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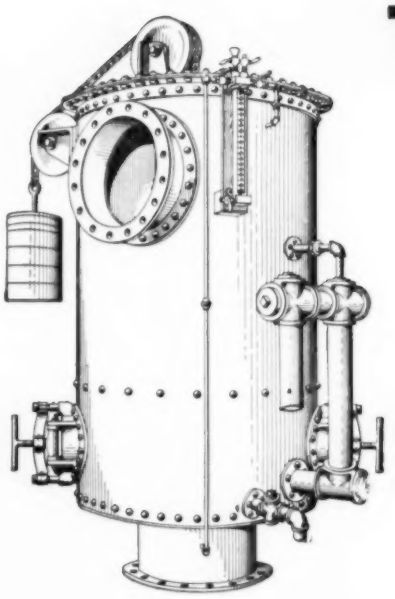

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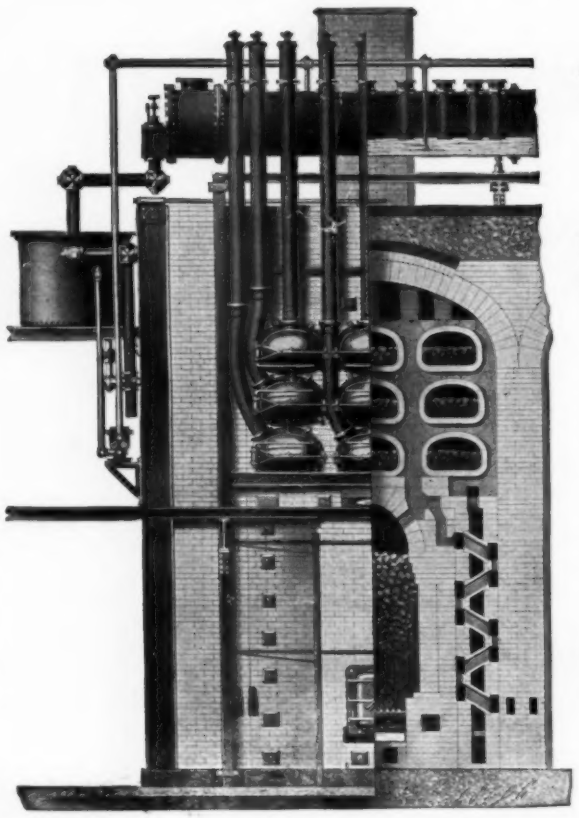

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THE ASTORIA TUNNEL UNDER THE EAST RIVER FOR GAS DISTRIBUTION IN NEW YORK CITY.

Plans of 30 Years Ago—The First Gas Tunnel—Another Outlet Needed—The Location—Constructing the Shafts and Tunnel—Change in Design—Work in Decomposed Dolomite—Reinforcing the River Bottom—Trouble from Water Flows.

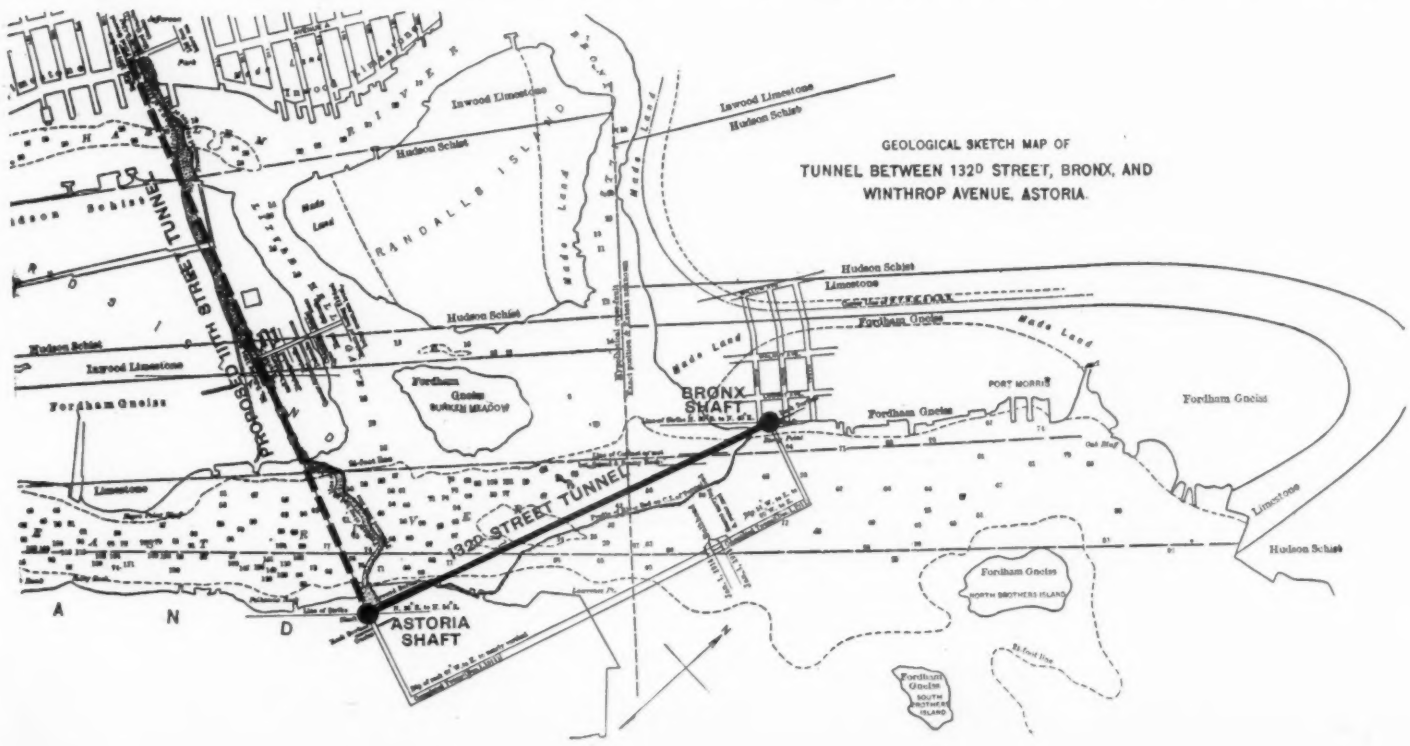
From the paper by JOHN V. DAVIES, to the American Society of Civil Engineers.

About 35 years ago, the production of gas within the City of New York had reached such a point, with reference to the occupation of lands for manufacturing plants and local interference with city development, as to make it desirable to consider the removal of these industries from the densely populated streets of the city. Consequently, on June 21st, 1886, at the request of Mr. James W. Smith, then President of the Consolidated Gas Company, a report, outlining the future policy of the company, was presented by Mr. William H. Bradley, then Engineer of the 44th Street Station, now Chief Engineer, in which the removal of the gas plants from Manhattan Island was advocated. The question was also ventilated in the public press, with strong advocacy of the suggestion that all companies manufacturing gas on the Island of Manhattan move to sites outside the city, and that a grand central manufacturing plant be created on the Flushing Meadows, from which gas should be piped to a convenient point whence it might be conveyed by tunnel under the East River to Manhattan. At that time the Ravenswood Gas Company, having a small manufacturing plant at the foot of Webster Avenue, supplied gas in Long Island City, and in 1891, this company was reorganized by Mr. Emerson McMillin, its corporate title changed to the East River Gas Company, and it obtained from the Legislature franchise rights to supply gas to New York City by a tunnel constructed under the East River.

In 1892 and 1893 the writer's firm constructed, for that corporation, a small tunnel (internal diameter, 10½″ or 10 feet 2″ in the portions, iron lined and a rectangler section, 10 by 8 feet, in solid rock) under the East River, crossing the two channels and Blackwells Island, to the foot of East 71st Street, Manhattan.

After the completion of this tunnel, the East River Gas Company passed into the ownership of the Consolidated Gas Company, and thereafter, the Astoria Light, Heat and Power Company was organized to construct a great central gas manufacturing plant to supply gas to all the constituent companies. This plant was established at Lawrence Point, Long Island, at the northerly end of the channel known as Hell Gate.

For several years gas from both the Astoria and Ravenswood plants, for the supply of Manhattan and the Bronx, had been carried through a pipe line to Ravenswood, and thence through the



71st street tunnel in two 36″ mains to Manhattan. The supply for the Bronx had been through pipes laid in open coffer-dam construction across the Harlem River, involving a devious detour. About 1903 it became necessary to consider other means of getting the gas from the Astoria plant to Manhattan, as the center of gravity of gas consumption of Manhattan and the Bronx combined was at a point just south of the Harlem River.

Long legal proceedings to obtain an easement for a right of way for a tunnel delayed this undertaking for several years. The line of the tunnel was definitely fixed by the necessities of the commercial situation. The New York terminus had to be at 111th street and Pleasant avenue, where the company had a distributing station, and the Long Island terminus had to be on the property of the company at Astoria, just north of Winthrop avenue. The line, therefore, was laid out between these points, the Astoria end kept as close as possible to Winthrop avenue, passing under Ward's Island, where it was intended to sink an intermediate shaft and to drive a branch tunnel to a point in the Bronx. Borings were made at the sites of the entrance, outlet and intermediate shafts, and the geological features carefully studied.

As the depth of the water in the channels was more than 100 feet, so great that it was impossible to use air pressure, and as the geological conditions made it certain that the contacts between the gneiss and dolomite formations would give trouble, it was decided to place the tunnel deep in the rock. The depth decided on was 186½ feet below mean sea level at the Manhattan shaft, descending to 218 feet below that level at the Long Island shaft.

As before stated, these legal proceedings consumed considerable time, and in the interim the center of gravity of gas consumption moved above the Harlem River, with every indication that it would go still farther north ; and, by the time the company was ready to proceed with the work, it was decided to shelve the plan for a tunnel to 111th street, and to proceed with that direct from the Astoria plant to the Borough of the Bronx. This rearrangement necessitated the retention of the shaft near Winthrop avenue, Astoria, and the purchase of land at Port Morris at the foot of 132d street, for the northerly outlet of the tunnel, near to the Central Union Gas Works, at the foot of 138th street and Central avenue, the Bronx.

The location of the underground prism for the easement for the tunnel to 111th street determined the depth of the Astoria shaft for the tunnel to 132d street, and the necessary drainage gradient toward Astoria determined the depth at the Bronx shaft. The grade of the tunnel was lowered to the utmost limit permissible within the prism forming the subterranean easement, as it was recognised that on this line the axis of the tunnel would be nearly parallel to the line of strike of the rock, and to the planes of contact between the different geological formations to be penenetrated, and therefore, in all probability, would involve more difficulties than the projected tunnel to 111th street, which passed almost at right angles across these contacts. However, the company considered that, notwithstanding this, it would be wiser to face the constructive difficulties than to adopt a new location and revive all the legal proceedings.

On account of the uncertainties of what might arise in construction, the company decided not to invite bids from contractors, but to carry out the work by its own forces, and the writer's firm was retained as constructing engineers.

The following description records for the most part a work of tunnel construction of large magnitude, but comparatively simple in character, excepting only that the general location was at a deep level, with access only at vertical terminal shafts nearly a mile apart, and practically entirely below navigable waterways.

Construction.—The construction involved, a vertical shaft, 227 feet deep, on the property of the Astoria Light, Heat and Power Company, another 242 feet deep, on private property in The Bronx, and a tunnel connecting these shafts.

Anticipating the future construction of the previously planned tunnel to 111th street, Manhattan, the shaft at Astoria was made larger than the one at The Bronx, and a short portion of the tunnel on the line to 111th street, was constructed, so that, as future necessities arose, it could be extended without disturbing the Astoria-Bronx service.

The necessities for the gas distribution required two 72″ cast iron mains from Astoria to The Bronx, with space in the upper portion of the tunnel for additions. This caused the adoption of a tunnel cross-section 18 feet on the vertical axis and 19 feet on the horizontal axis. The vertical pipe risers, elevator frames, etc., made it necessary that the shaft should be 26 feet in internal diameter at the Bronx terminal, and to provide for both a Bronx and a Manhattan tunnel, made the internal diameter of the Astoria shaft 34½ feet.

Borings at the shaft sites showed that on the Astoria side there was a solid rock floor approximately 50 feet below the surface of the ground, or about 40 feet below mean sea level, the overlying material being a natural deposit of sand, gravel, and boulders, which, so near the East river, assured considerable water inflow in excavation. At the Bronx shaft the rock floor was only 13 feet below the surface of the ground, and was overlaid with boulders, beach sand, and gravel. Soundings along the line of the tunnel indicated two river channels, each having a water depth of approximately 100 feet, with a high reef lying between them. The geologic survey maps indicated certain changes in the geological formation, with Stockbridge dolomite lying between the Fordham gneiss, which exists at the locations of the two shafts and extends for a considerable distance from each. The two deep-water channels clearly define the contacts at each end between the gneiss and dolomite.

Astoria Shaft.—The sinking of the Astoria shaft began on September 12th, 1910. Steel sheet piling was used for the exterior sheeting through the earth section, for a depth of 52 feet, braced with 16-sided timber frames, 4 feet apart. Excavation was re-removed as the sheet piling was driven, in order to avoid any distortion by over-driving against boulders or rock.

Having sunk the shaft to rock level, excavation was carried down into the rock about 4 feet below the pilling, and concrete was placed to half the ultimate thickness for the full depth of the excavation, in order to secure the sheet-piling and timber frames from injury during the further extension of the shaft.

Bronx Shaft.—At the Bronx shaft, with the shallow depth of the overlying soil, wooden sheeting of 4″ tongued and grooved stuff, supported by 12-sided timber frames, 4 feet apart, was used to rock level ; the permanent lining inside this sheeting was concreted on reaching the rock floor.

Fig. 1.—Head-Horse, Astoria Shaft.

Shaft Sinking in Rock.—Shaft sinking in rock was carried out by ordinary methods, the usual practice being to line up with concrete every 30 feet, as the rock was of treacherous character, and the lining insured against accidents.

For hoisting and removing excavated rock, and to avoid using a swinging bucket on the boom of a derrick, the permanent head-frame, Fig. 1, (equipped later for elevator cages), was erected, with overhead hoisting sheaves and the elevator hoisting engines. One of these elevator wells was then fitted with guide-framing below the landing, and at the level of the landing a broad-guage track crossed the elevator opening, with trap-doors fitted to insure safety. The spoil buckets were hoisted through this trap and landed on a flat-car run through the elevator opening before the hoisting rope was detached.

Water entered from numerous rock joints at various points in sinking the shafts, but not in such volume as to retard the work, except by the time lost in removing the pumps and hose when blasting. This water was readily handled in each shaft by one 350-gallon per minute steam-driven pump.

Two water rings were placed in each shaft as the sinking proceeded, to intercept tho water seepage and prevent it from pouring on the men working below. Each ring was a 6″ wooden shelf, with gutter board sheathed with zinc, and a 3″ pipe extending to the shaft bottom for drainage.

At the bottom of the Astoria shaft the design provided for an enlargement, 41 feet high, 34½ feet wide, and extending some 19 feet beyond the neat shaft lines, to be used ultimately as an operating chamber for the distribution of gas, but it, as well as the short length of 100 feet of tunnel in the direction of 111th street, was utilized, during construction, as a pump chamber and store room. The enlargement extended 16 feet below the tunnel invert, and contained a 5-foot circular sump 8 feet deep, for the accumulation of the expected water flows and for settling solid matter carried with it.

Bronx Shaft Sump.—As the tunnel drained southward toward Astoria, a similar sump was not required in the Bronx shaft, but a rectangular sump, 21 feet long, 12 feet wide, and 8½ feet deep, was put in.

Tunnel Driving Under Normal Conditions.

Bronx Heading.—The Bronx shaft reached a sufficient depth for turning the heading on February 12th, 1911, and the heading was driven for a short length before completing the shaft and sump, and tunnel driving really began on March 8th and continued under normal conditions through sound, close-grained gneiss until August 29th, 1911. At that time the first appreciable delay occurred, the heading entering the expected contact seam of decomposed, water-bearing dolomite, 771 feet from the shaft center.

Astoria Heading.—At the Astoria end, work on the main tunnel did not begin until August 8th, 1911, when the headings of both the Bronx and Manhattan tunnels were already turned. As in the Bronx, the headings were turned when the shaft reached the level of the floor of the top heading. The advance toward the Bronx continued until April 23d, 1911, during which time about 80 feet of the Manhattan branch tunnel were driven. Owing to the large chamber arrangements necessary at the bottom of the Astoria shaft, work on the main tunnel was not resumed from this end until June 23d, 1911, and it continued without incident until November 7th, 1912, a distance of 3,536 feet from the shaft center.

Geology.—For the first 1,200 feet from Astoria the tunnel is through a hard, compact and tough granite gneiss, requiring heavy drilling and large consumption of powder. For the next 2,336 feet it passed through the dolomite, and the passage through the easterly contact between the gneiss and the dolomite was made without any apparent disturbance or shear of the geological structure, a condition quite different from the contact encountered in the Bronx heading, where the geological change was featured by violent shear, accompanied by innumerable water fissures and excessive disintegration. At a point 3,536 feet from the Astoria shaft the heading met the first indications of the water-bearing disintegration of the westerly contact between the gneiss and the dolomite. It developed that the width of this decomposed contact normal to the strike was some 150 feet, whereas the angle of crossing made by the tunnel involved a total distance of 450 feet between points of contact on the two side lines.

Excavation.—For the tunnel excavation, the top-heading-and-bench method was adopted, maintaining the bench some 50 feet behind the heading. During the early part of the work the arch lining was not placed as the excavation advanced, these exposed sections being concreted later by using steel forms, and work was performed simultaneously with, and without hindrance to, the driving of the heading and bench. On deciding to place the arch lining along with the tunnel advance, a system of alternate excavating and concreting was adopted, with excellent results as to progress obtained. This method consisted of excavating both the heading and bench from 8 A.M. Monday to 8 P.M. the following Friday, the remainder of the 6-day week (until 8 A.M. Sunday) being occupied in placing the concrete arch. By this method the maximum monthly progress was made, being 269 feet of full tunnel section excavated and arch lined. The average progress by this method was 53 feet of heading, bench and concrete arch per 6-day week, which, in volumetric measure, equalled 675 cubic yards of neat-line excavation and 81 cubic yards of neat-line concrete arch.

Based on the results in this table, the average monthly (30-day) advance of completed tunnel, excavation only, was 284 lin. feet, or 4,054 actual cubic yards in one heading.

Although the rate of progress was not as great as in other tunnels of which reports have been published, the results obtained are thought to have been very satisfactory, considering the general conditions of hoisting from a deep level, particularly as at no time was it considered by the management desirable to enter into the system of bonusing men to obtain record results. The entire work was carried out on a normal wage basis.

Progress of Rock Excavation in Tunnel under Normal Conditions.

	Linear feet of full Tunnel section.	Average Daily Process. Linear feet.	Actual cu. yards.
Fordham Gneiss:			
Astoria end	1,195	8.72	127.7
Bronx end	757	6.62	94.9
Mean	1,952	7.79	113.0
Stockbridge Dolomite:			
Astoria end in dolomite	2,322	11.68	164.4
Mean Astoria end, in gneiss and dolomite	3,517	10.43	148.8
Mean result for both ends of tunnel, in gneiss and dolomite	4,274	9.46	135.1

Concrete Arch.—The portion of sound rock tunnel driven from both the Bronx and Astoria shafts was a hard, solid structure, but the rock indicated extensive jointing, with a tendency to scale away and fall without warning, due to the character of the rock and also to the heavy blasting. Therefore, it was decided to construct the arch lining, and, on account of the original cross-section adopted, to finish the arch lining to a skewback intended for the bottom concrete, in which the permanent cast iron mains were to be solidly embedded; this arch lining, hanging to the arch, was supported only on the irregular jointed section of the rock walls.

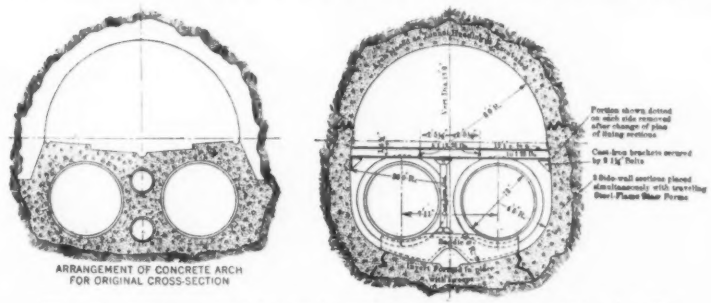


Fig. 2.—Sequence of Operations in Placing Concrete Linging for Final Cross-Section.

Change of Design.—From the commencement of this work it had been contemplated to embed the cast iron pipes solidly in concrete, and to make a floor above them, but, after 2,867 feet had been lined in this way, a revision was made, the pipes to be left exposed and a deck inserted above them. The tunnel has been left completed according to this plan (Fig. 2). This necessitated cutting out portions of the arch lining and skewback that had previously been constructed. In the remaining length of the tunnel, the arch concrete was supported by timber sills on posts, the side-walls and invert not being placed until the complete excavation of the tunnel from end to end, when the sills and posts were removed, as the wall lining proceeded.

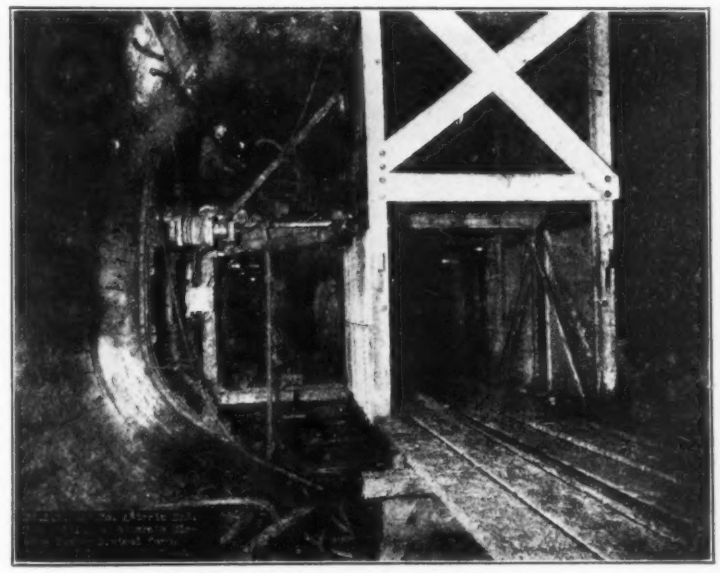


Fig. 3.—Steel Form for Placing Concrete Lining.

This method of procedure was peculiar, in that, for the entire job, the arch lining was first executed. Then, when the tunnel was holed through, and the steel lining, hereinafter described, was

being erected in the decomposed section, the invert was put in place by trimming the rock floor, in lengths ahead of concreting and laying the invert, to accurately placed side-forms. On the completed invert, after it had come to strength, was laid a 60-inch guage track, on which were operated two complete collapsible steel forms, each 50 feet long, used for the construction of the intervening side-walls, the two side-walls being concreted simultaneously.

These forms had on the bottom frame a standard tunnel-gauge track, with a short incline at each end, so that operations in the tunnel could proceed by running the tunnel cars through the lower portion of the steel frame. There was an elevator at the ends of each form to raise the concrete cars to the upper level, so that they could be run to any point for dumping. The collapsible feature of the steel forms was obtained by using jacks and turnbuckles, and the upper platform of the forms, which was the dumping platform, was practically at the springing line of the arch where the joint was made between the side-walls and the arch already in place.

Tunneling Through Decomposed Water-Bearing Dolomite.

As stated previously, no evidence of any shear or disintegration was disclosed at the eastern contact between the gneiss and the dolomite; but the western contact, encountered from the Astoria end, showed highly decomposed dolomite with a heavy flow of water. The seams were so decomposed that the material consisted only of a micaceous green, sand, so porous that, on exposure, water quickly formed a free passage.

Fig. 4.—Heading at Station 37 plus 00, Showing Sand Hole.

The first contact with the decomposed rock indicated a likelihood of getting through the contact without serious difficulties, as the tunnel, after careful grouting, was advanced a considerable distance in rock, which, though excessively distorted and water-bearing, had sufficient strength to carry the pressures without danger. At the same time, it was desirable to protect this heading as it advanced, and the arch was carried on heavy timbering in order to guard against falling rock. Having extended this length on timbering, it was thought that the insertion of cast iron lining in this section might enable the work to advance successively, particularly as the rock appeared to be getting stronger and harder beyond the first point of contact. As immediate delivery could be obtained of cast iron segments made from the patterns for the Pennsylvania R. R. North River Tunnel, a length of 50 lin. feet was bought and erected in this wet, water-bearing, rock section; and inside the iron lining, concrete was inserted to the neat finished section adopted for the tunnel. This lined section remained in place in the finished work as an intermediate portion between two sections of cast steel internal lining subsequently erected.

The rock structure 893 feet from the center of the Bronx shaft, in addition to being extremely porous, was greatly shattered. The dolomite appeared like a mosaic of inlaid tile slabs, 3 to 4 square inches, and readily removed by hand, although the individual pieces were moderately hard. It was at this place that three large water-flows burst forth at various times. One was an average single flow of 1,000 gallons per minute, and carried in sediment large quantities of green sand and hard rock fragments. Here, too, it was necessary to terminate two heading drifts from the Bronx end. To the north of the assumed cross-fault, the actual contact between the gneiss and dolomite consisted of a continuous small seam, ¼″ wide, of soft brown mud, and to the south of this point the contact plane was featured by a 3 to 4-feet seam of hard, firm, bluish-green clay.

Fig. 5.—Water Flow in Drift at Station 37 plus 71.

Water Flows.—The water-bearing fissures in the decomposed dolomite were quite numerous, sixteen appreciable streams, averaging from 300 to 10,000 gallons per minute, each under a full pressure head of 95 pounds, being encountered. These flows were usually quite sudden, and were accompanied by an inrush of greensand, the maximum flow of 10,000 gallons washing in 400 cubic yards of sand, coal, etc., and, during a period of 6 weeks, some 1,700 cubic yards of sand were washed into the Astoria heading. The establishment of a direct connection to the river bed was proved by the appearance of air bubbles on the river surface during grouting operations in the headings, as well as by the quantities of coal, wood, shells, bricks, etc., washed in at various times.

Method of Attack.—On account of the great depth of the tunnel and the resultant pressure head (95 pounds per square inch), any compressed air methods of attack were out of the question, and not desiring to go to any lower level in an attempt to pass under the disintegrated bed of dolomite, it was necessary to drive the tunnel to the original depth and alignment; so the proposition presented was a difficult one.

Fig. 6.—Grout Pipes, Station 38 plus 55 to Station 39 plus 09.

The theory on which tunneling was executed through the decomposed rock was thorough exploration of the formations ahead by test holes and consolidation of the rock by grouting. It is obvious, in working in a narrow top heading, even by drilling numerous holes in the form of a fan, that a very limited area could be reached for consolidation, and as the percussion drill, working on more or

less horizontal or dry holes, is only capable of extending to a depth of about 20 feet, the tunnel section that it is possible to consolidate is very short, particularly in view of the fact that there is a definite limit to the number of grout holes that can be drilled into the face of such a small heading (Fig. 6), and that considerable time must be allowed for cement grout to attain strength to permit of blasting safely. It was obvious, therefore, that a greater area of attack must be provided, and this was done by diverting the heading from the straight line to lines external to the final side lines of the tunnel, following the line of the strike of the sound rock as far as possible. By doing this a long face could be exposed from which the drilling could proceed. Further, whenever the rock was sound and reasonably hard, adequate anchorage for the grout pipes was provided, but, if the rock was decomposed, seamy and water-bearing, it was usually found to be so soft that proper anchorage could not be obtained for them. In such cases it was necessary to construct buttress faces to the soft rock after exposure, before grout pipe holes could be drilled and pipes inserted. The work was carried out on the further theory that grouting above the extrados of the arch and outside the side walls, within the limit of the top heading, would in all reasonable probability cut off the direct access of heavy water flow and consequent danger of breaks occurring in the bottom. This was carried out to the end of the work and proved successful, as was illustrated by the fact that it was found unnecessary to do any grouting of considerable extent in order to take out the later bench excavation, the water-bearing seams having evidently been plugged at the higher level and the resistance of the decomposed material in the seams being adequate to resist any indirect access or flow.

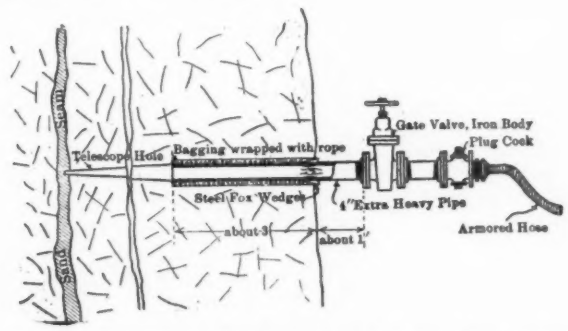


Fig. 7.—Diagram Illustrating Insertion of Grout Pipes in Rock for High Pressure Grouting.

The process of preparing the grout pipes for use, as indicated by Fig. 7, was generally as follows:

The drilling was commenced with 6″ percussion drills, and entered 3 to 4 feet into the concrete buttress or hard rock. A piece of 4″ pipe, about 1 foot longer than the depth of the hole, was wrapped tightly with bagging and wound around with marline. The wrapped pipe was then inserted in the hole, and driven to its extreme end. When thus inserted the wrapping was caulked back into the hole, and steel wedges driven tightly between the outside of the hole and the body of the 4″ pipe. A screwed flange was then put on the outer end of the 4″ nipple, and a gate valve attached. Drilling then proceeded through the gate valve, commencing with 3″ percussion drills and telescoping if necessary, as the drilling advanced. The length of the test holes rarely exceeded 20 feet. Of course, where the drilling was carried out from narrow cross-headings, and the holes were drilled at an angle with the strike, the effective length was reduced by the lack of clearance to insert long drills.

The grouting in the Astoria Tunnel probably exceeded considerably that in any other work executed for consolidating soft fissured rock and in stopping large leaks at high pressure. Grouting at a higher pressure was done on the Catskill Aqueduct, though the volume of inflow was probably very much less. In the Astoria tunnel, the grouting was a continuous operation for consolidating and cementing decomposed rock throughout the entire length of the sheared contact between the gneiss and dolomite, and served the purpose, a result which has not been approached or attempted in other work. It was the conversion of a rotten and decomposed rock filled with fissures into a solid and substantial substance through which the tunnel could be driven. It was found almost impossible to grout into a seam of decomposed dolomite sand, and this would apply to any other sand or material seams filling that is likely to be scoured out by a flow of water. On meeting a seam filled with decomposed rock sand, the sand was practically impervious, but, after a short exposure to water flow, the soft rock abutting on the seam became water loaded and softened; then the passage of small quantities of water loosened the sand, following which it was scoured out, thus forming an open water channel. Therefore, it was found desirable, after drilling grout holes into a seam filled with sand, to rake the sand out with rods, as far as was feasible, and then to allow the test holes to flow freely and empty the seam, after which the grouting was much more thorough and permanent. When these seams were emptied of sand and grouted at high pressure the result was practically a solid rock formation, and the tunnel could be built by blasting operations with security; whereas a seam not so clear of sand would resist the flow of grout and be a menace to the future advance of the tunneling operations.

Grouting.—During the early stages, the grouting of the water-bearing fissures was performed with ordinary grout machines, using a neat Portland cement mortar at pressures of 100 to 200 pounds per square inch. But it became apparent, as the work proceeded, that pressure of even 200 pounds was insufficient. For grouting into narrow seams it is essential to obtain a high initial velocity of grout flow, in order to overcome the frictional resistance; and to grout against a water head of approximately 100 pounds per square inch, more than 100 pounds additional pressure was necessary. The increase of the starting pressure insured the initial flow, and the expansion of the air, even down to 200 pounds or less, was adequate to maintain the continuity of the flow. The use of the high pressure also insured that the seam would be packed more tightly and that the grout would be more dense when it had taken its ultimate set.

The disintegrated rock structure frequenty necessited the construction of concrete wall buttresses, to withstand the high grouting pressures, and considerable difficulty was experienced during the early stages of the work in preventing the injected cement from washing out of the water-bearing crevices. Unsuccessful efforts were made to prevent this by mixing oats and bran with the cement mortar, as used in other subaqueous tunnels.

Another method that was of great benefit consisted of adding a handful of fine-cut cotton waste to each batch of grout, which, by fibrous reinforcement of the cement, held it in place while setting. During lengthy grouting periods, two machines were used alternately in series, thereby maintaining a continuous injected flow.

Bulkheads.—Prior to entering the belt of disintegration at each end, precaution was taken to guard against flooding, by constructing full tunnel section emergency bulkheads. As the headings proceeded, additional emergency bulkheads, heading size, were built, as the bench was not removed through this soft-ground section until after the meeting of the headings.

The first emergency bulkhead of full tunnel section, built at the Bronx end, was of a concrete buttress type, fitted with two guillotine doors, and not reinforced. A guillotine type of door was considered in the first design to be the most certain in action. The clear openings of these doors were about 5 feet square, to permit a tunnel car to pass. These doors were never closed or used, but for later doors it was considered favorable to adopt a top-hinged flap, so that, in case of necessity, by cutting away the wire-rope supports, they would drop readily into position. They were equipped on the outer side with tripping devices and rams, operated by compressed air from the tunnel line for opening, and valve arrangements were provided so that the door could be operated from inside or outside; thus in the event of anyone being accidently left on the wrong side, it was possible for him to open the door and release himself.

During the bench removal, after holing through the headings, full section tunnel emergency bulkheads were necessary, these being generally about 14 feet thick.

Bench Excavation.—After the meeting of the headings, on July 17th, 1913, efforts were concentrated on the removal of the remaining bench, which at that time, amounted to 474 lineal feet. This was attacked simultaneously from the Astoria and Bronx sides. In the first 237 feet on the Astoria side good sound dolomite was encountered, and immediate lining was not necessary. On the Bronx side the lower west portion of the bench face consisted of hard sound gneiss with intrusions of clay at its contact with the dolomite on the east. The dolomite was both porous and disintegrated, but no serious difficulties were encountered, although it was necessary to place the concrete lining immediately after each short advance of excavation. The advance was thoroughly explored with long test holes ranging well outside the excavation lines, and the material was displaced by light blasting, not only because of the character of the rock, but on account of the overlying concrete arch.

The work proceeded in this manner until test holes disclosed the presence of excessive water at the Astoria side of the remaining bench. These holes were piped for grouting and incased in an in-

clined concrete buttress, 20 feet long and extending from the arch haunch to the rock bench. The water was allowed to flow freely through the holes for a week, while the concrete buttress was attaining strength, and the valves of the drains through the inclined buttress then closed in preparation for grouting, when water broke through the top of the bench at the toe of the buttress. It was then decided to place a full section emergency bulkhead at each end of this 122-foot section of bench, so that any water that might overcome working operations could be confined. On the completion of these bulkheads, on September 16th, the work of preparing to consolidate the rock was resumed. The inclined buttress was removed and a much more massive one constructed, extending along 34 feet of the bench top, from the recently constructed emergency bulkhead on the Astoria side, about 6 feet high and 12 feet thick.

At the same time, the western side of the bench top, at the Bronx side, was covered with a 23-foot length of inclined buttress against the concrete arch and extending from the recently constructed Bronx emergency bulkhead to a heading emergency bulkhead on top of the bench placed during the driving of the Astoria heading. A similar inclined buttress, 13 feet long, was placed against the west side of the arch. Thus, the entire 122 feet of exposed bench was covered on the west side by a series of concrete bulkheads and buttresses,

After allowing these structures to set, grouting through them into the rock fissures began, and 139 bags of cement were successfully injected into the last two mentioned buttresses. The grouting of the massive 34-foot buttress was not successful, as the reactive pressure developed by the closing of the drain valves fractured the concrete badly and rendered it useless.

It was then decided to replace it with one in the form of an inverted arch, and of more massive proportions, the arch to react against the permanent roof arch already in place. In removing the buttress blasting was done with extremely light charges, and every care was taken not to disturb the underlying rock bench. Its removal was completed about 8 A.M. on Sunday, October 5, 1913.

(To be Continued.)

Natural Gas Production in 1914.

Statistics of the United States Geological Survey, show that the quantity of natural gas commercially utilized in the United States in 1914 exceeded that in any previous year. The quantity produced, 591,866,733,000 cubic feet, valued at $94,115,524, constitutes a new record of production, exceeding by nearly 10 billion cubic feet, or almost 2%, the former record, established in 1913.

Increases in output in 1914 over 1913 were credited to New York, Ohio, Oklahoma, Texas, Louisiana, Alabama, Iowa and California, the State last named alone recording a gain of nearly 7 billion cubic feet. Other gas-producing States recorded declines in output, the greatest, that of Pennsylvania, amounting to slightly more than 10 billion cubic feet.

The increases in gas production may be attributed to various cases—in New York, to the increased drilling activity stimulated by the advancing petroleum market in 1913 and the early part of 1914 ; in Ohio to local extensions of the productive fields of the gas belt in the central part of the State, and to the development of an important gas pool in the vicinity of Cleveland ; in Oklahoma to the development of gas reserves in the Cushing field, and the Healdton field, as well as to a decided expansion of the casinghead gasoline industry ; in Texas to a greater utilization of the gas supplies available in the Petrolia and Mexio fields ; in Louisiana to the greater development in Caddo and De Soto parishes ; and in California to increased demands for domestic consumption in Los Angeles and adjacent towns in the Southern part of the State, as well as for industrial consumption in the casinghead gasoline industry.

Of the record-breaking production of 1914 it is estimated that a total of 203,104,358,000 cubic feet, about 34% was supplied to domestic consumers at an average price of 28.04 cents a thousand cubic feet ; and that 388,762,375,000 cubic feet, the remaining 66% was supplied to industrial consumers at an average price of 9.56 cents a thousand cubic feet. During the last 4 years the ratio of domestic to industrial consumption has varied but slightly. Formerly, however, a relatively greater proportion of the annual yield was supplied to industrial consumers.

Production and Consumption by States are given in the Table :

State.	Produced.			Consumed.		
	Quantity. (M. cu. ft.)	Cents per M. cu. ft.	Value.	Quantity. (M. cu. ft.)	Cents per M. cu. ft.	Value.
West Virginia	238,740,162	14.87	$35,515,329	95,147,247	7.71	$7,334,690
Pennsylvania	108,494,387	18.80	20,401,295	164,834,542	17.25	28,439,324
Ohio	68,270,174	21.48	14,667,790	138,388,914	21.63	29,936,642
Oklahoma	78,167,414	10.30	8,050,039	55,544,105	7.61	4,226,318
Kansas	22,627,507	14.76	3,340,025	45,250,816	15.83	7,163,746
California	17,828,928	16.33	2,910,784	17,828,928	16.33	2,910,784
New York	8,935,187	29.10	2,600,352	18,401,830	29.94	5,510,204
Texas	13,433,639	18.38	2,469,770	13,433,639	18.38	2,469,770
Louisiana / Alabama	26,774,695	8.32	2,227,999	26,774,695	8.32	2,227,999
Indiana	2,579,675	29.28	755,407	4,443,244	32.02	1,422,880
Kentucky	1,421,818	34.52	490,875	7,225,626	24.73	1,787,308
Illinois	3,547,841	12.32	437,275	3,547,841	12.32	437,275
Arkansas / Colorado / Wyoming	962,998	22.23	214,103	962,998	22.23	214,103
South Dakota / North Dakota	60,781	44.78	27,220	60,781	44.78	27,220
Missouri	18,085	29.41	5,319	18,085	29.41	5,319
Michigan	2,042	70.61	1,442	3,042	70.61	1,442
Tennessee	1,200	25.00	300	1,200	25.00	300
Iowa	200	100.00	200	200	100.00	200
Total	590,866,733	15.90	$94,115,524	591,867,733	15.90	$94,115,525

RECENT DEVELOPMENTS IN THE DOHERTY WASHER COOLER AS A GAS CONDENSER.

Paper by R. B. ROWLEY, to Michigan Gas Association.

In 1907, Mr. Wm. Seymour favored this association with a paper on "A new Method of Condensing and Scrubbing," in which he described the first installation of a Doherty patented washer cooler as a coal gas condenser, at Grand Rapids. Briefly, this type of apparatus consists of a device whereby the crude gas is brought into direct contact with a supply of cooling liquor, which cools the gas and at the same time washes out mechanically the substances separated during the cooling. The liquor is then cooled in coils, and returned to the gas compartment for further use. The installation referred to consisted of an apparatus divided into eight compartments, through which the gas passed alternately up and down. This resulted in a parallel current of gas and liquor in four compartments, and a counter current flow in the other four. Each compartment was equipped with a circulating pump and a set of cooling coils, and separate liquor circulation was maintained in each.

Four years later Mr. L. E. Worthing presented to the American Gas Institute a paper on "Some Principles of Condensation with Especial Reference to Water Gas," in which he gave a description of a washer cooler that was being used by the Detroit City Gas Company as a water gas condenser. This apparatus consisted of a three compartment unit, in which the gas passed upward in each compartment, making a counter current flow of the gas and liquor throughout, and a separate pump and circulation were used on each compartment. With this installation the cooling was reduced to triple stage.

In 1910 Mr. W. S. Blauvelt presented a paper to this association, in which he described an installation of washer coolers used as coal gas condensers at the Detroit plant of the Semet-Solvay Company, which company holds the rights for this type of apparatus in the coke oven field. These washer coolers were put in about the same time as the three stage apparatus installed by the Detroit City Gas Company, and were intended to operate in two stages, that is, the cooling was done partly in a primary cooler, and completed in a secondary unit. This installation required only two circulating pumps and two separate liquor circulations, and the cooling was reduced to double stage.

In the few years between the installation of the first Doherty washer cooler at Grand Rapids and the adoption of two stage cooling by the Semet-Solvay Company at Detroit, the system had been reduced from an apparatus cooling in eight stages to a system using only two.

Since 1910, the capacity of the Detroit plant of the Semet-Solvay Company has been increased, by steps, from 1,200 tons of coal daily, to 2,400 tons. In order to increase the capacity of our condensors, and to better handle apparatus cleaning arising from this increase in output, the two stage system has gone through a further simplification, and has been remodeled to a single stage system, in which all the cooling of the gas is performed in one operation in a single unit. It is the purpose of this paper to show some of the reasons why this change was made, and to give a brief outline of the condensing system and its operation as it now is.

At the Detroit plant the gas coming from the ovens during the first part of the coking period (rich gas) is kept separate from that evolved during the latter part of the coking (lean gas), which is used for fuel at the plant. This makes necessary the installation of independent cooling and scrubbing apparatus for the rich, and lean gas. With normal operation both the rich and lean gas leave the hydraulic main practically saturated with water vapor. As the operation is on a very large scale, the effect upon the total gas output, of fluctuations caused by charging and discharging one oven is very slight, and the temperature of the gas entering the coolers varies but slightly from day to day, and only a few degrees from season to season. For this reason it is possible to determine accurately the quantity of heat that must be removed for a definite quantity of gas entering the washer cooler at any given temperture.

With the washer cooler and the direct contact method of cooling using the counter current flow, a maximum heat transfer is obtained by bringing the temperature of the gas leaving the top of the cooler to the temperature of the cooling liquor entering there, and by bringing the temperature of the liquor leaving at the bottom of the apparatus as closely to the temperature of the gas entering as possible; without endangering the positiveness of the cooling in case of an increase in the output. Operating a washer cooler this way, it is only necessary to supply a volume of cooling liquor capable of absorbing the heat of vaporization of the condensable vapors carried by the gas, which from a thermal standpoint consist chiefly of water vapor, and to cool the gas itself. Since the condensate and circulating liquor leave the bottom of the cooler almost at the temperature of the gas entering, very little cooling of the condensate is required within the column. Although the condensate that separates near the top is cooled, it is heated again before separating from the gas.

The quantity of heat it is necessary to abstract per minute, to cool one million cubic feet per day of gas saturated with moisture from various temperatures, is shown graphically on Plate I. The figures given include the heat necessary to abstract from the gas to lower its temperature, and the quantity that must be removed to condense the water vapor. It does not include the heat removal necessary to lower the temperature of the condensate, as this is not done in the washer cooler itself, when operated in this way. The heat removal required to condensate the hydrocarbon vapors carried by the gas has been neglected as it is a very small per cent. of the total heat.

These figures were calculated from a table of data prepared by Mr, H. A. Humphrey, published in the Proceedings of the Institute of Mechanical Engineers for 1900. This table is reprinted in Appendix I. The figures have been checked against our practice, and agree very closely with our actual heat removal.

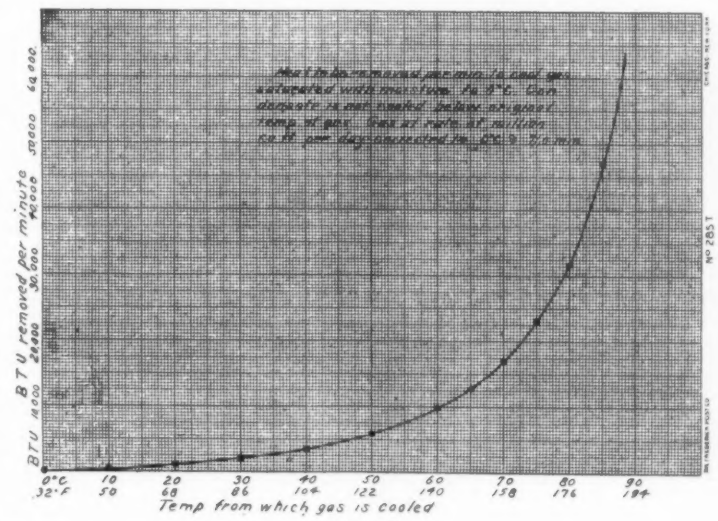


Plate I.

From this curve it can be seen that the thermal capacity of gas saturated with moisture is much greater per degree change of temperature at the higher temperatures; and that the quantity of heat to be removed per decree of cooling becomes greater, at a continuously increasing rate, as the temperature rises. For our work it is not necessary to consider gas above 85° C. (185° F.), although the recent tendency toward faster coking times and higher oven temperatures, tends to increase the temperature at which the gas enters the condenser. If the gas enters the cooler saturated with moisture at 85° C. (185° F.), it can be seen from the table that 47,000 B. T. U.'s must be removed per minute to cool one million cubic feet of gas per day 0° C. (32° F.), and condense the water vapor. About 43,000 B. T. U.'s will be removed, however, when the gas temperature has been lowered to 42.5° C. (108.5° F.), or through half the drop in temperature desired. In other words, about 91.5% of the total heat is removed in cooling this gas to 42.5° C. (108.5° F.), through only 50% of the temperature drop.

It can be seen that, in this system of cooling, the capacity of any quantity of liquor for cooling depends almost entirely upon the range of temperature change through which it can be made useful. If heated from 42.5° C. to 85° C (108.5° F. to 185° F.), a certain quantity of liquor can absorb only 50%, as much heat as

(*Continued on page 234*)

THE AMERICAN GAS LIGHT JOURNAL

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SANFORD K. CAMPBELL, Editor.

NEW YORK, MONDAY, OCTOBER 11, 1915.

Benefits of the Sliding Scale.

Ex-Mayor Nathan Matthews of Boston, who in 1905 prepared a lengthy report on "The Public Regulation of Gas Companies in Great Britain and Ireland," which had much to do with the adoption of the sliding scale principle for Boston in 1906, has made a supplementary report of 47 pages on developments of the last ten years.

This report, the Boston Consolidated Gas Company, for whose benefit it was made, plans to present as evidence in the investigation to be made by the Massachusetts Gas and Electric Light Commission into the operation of the sliding scale, the terms of which, may, under the law, be altered after June 30, 1916.

He finds that "from the public standpoint, the sliding scale system seems to be more firmly entrenched in public opinion now than in 1905," and that "from the standpoint of the companies, managerical opinion respecting the sliding scale may be said to be even more favorable than in 1905."

Continuing his "conclusions, Mr. Matthews reiterates his opinion that the sliding scale has been accepted as the final solution of the gas price problem in Great Britain, and that it is the chief cause of the prosperity of the English gas industry and the low price enjoyed by the consumer.

"A satisfactory system of gas company regulation," he says, "should aim to secure six main advantages to the public: 1, low prices for gas; 2, progressive management; 3, extensions of service and sales; 4, harmony between the company and its employes; 5, satisfaction on the part of the consumers, and 6, a fair, permanent and easily understood basis for the relation between prices and profits.

"As between the maximum dividend companies and the sliding scale companies, the balance of advantage in respect to price has been with the latter, not only in absolute figures, but as to the time when reductions are made. In respect to management, service and the relations between the company and its employees, the advantage is wholly with the progressive methods of the sliding scale. And this system is the only one yet invented that successfully regulates profits upon the basis of a just and fair decision between company and consumer.

"There is no disposition in any quarter to change a system that, after 40 years of constantly increasing use, has so completely proved its possession of these advantages.

"There is in particular no demand for any change in the standard price without consideration and consent. When additional and valuable powers are sought by a gas company, the local authorities frequently object, unless some consideration is furnished by the company, and this return often takes the shape of a small reduction in the standard price.

"Nor was the writer able to find anybody who advocated any system of arbitrary price revision by the Board of Trade as a substitute for the simple, just and automatic operation of the sliding scale. Any proposition of this nature would be regarded as both an economic error and a breech of contract, and as a system likely in the long run to work less favorably, both to the company and their consumers, than the sliding scale."

A Clean Bill for Maine.

The Chairman of the Maine Commission, Benjamin F. Cleaves, speaking to a meeting of New England electrical men, said that if commissions are to live and be of use they must be regarded as a third party in interest, the public and the companies being the other two. Seven hundred companies are under the recently organized Maine board's jurisdiction, and their rates need to be made clearer to the ordinary individual; and the commission desires enlightenment in regard to the work and problems of the industry. Somewhat to the disappointment of the public, no evidence of fraud has been disclosed in public utility management in Maine. Confidence needs to be increased between the public and the companies, and this can best be done by thoroughly acquainting the commission with the business of the companies. "Regard us as human beings," said the speaker; "don't make us drag it out of you. You should have a fair return under all circumstances, and the public should not only receive fair treatment but should believe it is getting this. The public has got to know where it gets on and off in connection with this vehicle that you are driving."

The Chase for Dye Stuffs.

Advices from Washington tell that Japan has gone about the dyestuff industry in a way to get results speedily. The Government has voted a subsidy to all corporations engaged in the manufacture of dyes in Japan, provided that more than half the capital is subscribed by Japanese subjects.

The subsidy is extended to concerns making every form of dyestuffs and dye chemicals, including aniline salt, aniline dyes, alizarine dyes and synthetic indigo. The amount of subsidy will enable the companies to pay a dividend of 8% on paid-up capital, and will be for a period of ten years. Medicines or perfumery manufactured from coal tar by-products will be regarded as manufactured dyes and chemicals, as well as material for gunpowder.

The latest move at home is the announced incorporation of the Federal Dyestuff and Chemical Company of New York, with a capital of $15,000,000, said to be the means by which Standard Oil interests and the DuPont De Nemours Powder Company will enter the dye-making field. It has been understood for some time that large moneyed interests were ready to enter this field if assured of protection after the war by some anti-dumping law as protection from foreign competition; and it is reported that some such assurance has been given by Secretary Redfield.

A Well Deserved Tribute.

The following copy of a telegram speaks for itself:

San Francisco, Cal., Sept. 28, 1915.

Frederic Egner, 516 Quincy st., N. W. Washington, D. C.

It affords me great pleasure to inform you of your unanimous election as a Life Member of the American Gas Institute at its tenth annual meeting held at San Francisco this day.

(Signed) George G. Ramsdell,
Secretary.

This tribute to Mr. Egner's sterling qualities and ability as a gas engineer came as a great surprise to him, and the Journal hastens to add its congratulations to those of his many friends. May he live long to enjoy the honor.

INTERNATIONAL GAS CONGRESS SESSION.

(Special Editorial Correspondence, by Telegraph, from Dr. A. H. Elliott.)—(Continued from page 217.)

SAN FRANCISCO, CAL., Sept. 30, 1915.

Papers read to-day were:

"History of the Development of Water Gas," by O. B. Evans;
"Blue Water-Gas and Deep-Fuel Combustion, by A. G. Glasgow;
"The Substitution of Heating Valve for Candle-power, as a Standard for Gas Quality," by R. S. McBride.

They were discussed by Dr. Alex. C. Humphreys and Messrs. Morris, Spitzglass, Elliott, Britton, E. C. Jones, Earnshaw, W. A. Wood, Thuman, and closed by O. B. Evans. The Symposium on Carbonization was read by R. A. Carter, Jr., on behalf of the New York Society of Gas Engineering, and discussed by Messrs. Morris, Nettleton and Bond, closing with R. A. Carter. The paper was excellent, but requires time to digest; written discussion is promised by members after the meeting.

The symposium on Illumination, under direction of C. O. Bond, made a very profitable morning, and the following topics read:

"Gas Street Lighting," by Geo. S. Barrows;
"Office and Store Lighting by Gas," by Thos. Scofield and O. H. Fogg;
"Residence Lighting," by W. A. Morris;
"Industrial Gas Lighting," by R. ff. Pierce;
"Semi-Public Lighting," by T. J. Litle, Jr.;
"Buoy and Car Lighting," by George E. Hulse;

and discussed by Messrs. John A. Britton, Prof. Corey, Bond, Morris Tuttle, Dr. Humphreys and others. This was one of the most valuable events.

The Commercial Symposium consisted of the following topics:

"Commercial Policies," by C. Willing Hare;
"Public Relations," by E. N. Wrightington;
"Office Management," by C. N. Stannard;
"Orders and Complaints," by W. J. Clark;
"Accounting," by P. S. Young;
"Domestic Fuel," by R. E. Slade;
"Domestic Lighting," by J. D. Shattuck;
"Commercial Lighting," by E. M. Colquhoun;
"Industrial Fuel," by F. W. Frueauff;

and was under the chairmanship of Mr. C. W. Hare, and all were warmly discussed by Messrs. Jones, Strange, Spitzglass, W. A. Wood and others. Much profit should come out of this, as the keynote was "Good service" all along the line.

The English Symposium on Gas Practice, in the Manufacture, Distribution and Sale, was read by Mr. Geo. G. Ramsdell, and at this time the following cable message of greeting was sent:

"Walter T. Dunn, secretary, Institution Gas Engineers, London. Greetings from California: By resolution, the International Gas Congress thanks Institute for Symposium on Gas Manufacture and Distribution, and wishes you to convey to Mrs. Allen our sense of obligation and personal sympathy. We cordially reciprocate sentiments expressed in last paragraph of Mr. Goodenough's paper.

(Signed) "ALEX. C. HUMPHREYS, President.
"GEORGE G. RAMSDELL, Secretary."

The papers were of a high order and well discussed by Messrs. Morris, Jones, Humphreys and others. Written discussion was promised in the near future. The papers are full of interesting experiences and should be read by all.

No effort has been spared to give the lady visitors a pleasant time in San Francisco, and the California ladies, headed by Mrs. E. C. Jones and Mrs. John A. Britton, have been indefatigable in their efforts at entertaining. Various luncheons and auto rides to interesting places, both inside and outside of the city, have been greatly enjoyed. At the Exhibition Building, in Festival Hall, Mr. John A. Britton gave an address of welcome that was most cordial with true California spirit and generosity. Mr. C. C. Moore, President of the P. P. I. E., presented Dr. Humphreys with a bronze medal as President of the Gas Congress, and two bronze medals to Mr. E. C. Jones, as President of the American Gas Institute and Pacific Coast Gas Association. Then followed an organ recital, and Mr. W. D. A. Ryan gave a lecture on the illuminatien of the P. P. I. E., illustrated with colored lantern slides made specially for the Congress, It is impossible to speak moderately of the beauty of the effects, they must be seen.

In the evening, at the Inside Inn, about 550 members and ladies sat down to a fine dinner, that was full of interest outside of the excellent viands provided. Mr. John A. Britton was toastmaster, and his wit and repartee kept everyone in California humor. Among other things, a wireless message to Mr. Harry L. Savage from Governor Pinkham, of Hawaii, was received, sending greetings to the Congress, and a cordial invitation was extended to the Gas Engineers to meet in Honolulu.

Dr. and Mrs. Humphreys, Mr. and Mrs. E. C. Jones, Mr. and Mrs. Cressy, and Dr. A. H. Elliott were all connected on the receiver in the dining room, and could hear perfectly the signals over 2,300 miles of space. An answer was returned by Dr. Humphreys. Another interesting feature of the dinner was the presentation to the wife of President E. C. Jones of a beautiful Calabash, made by an ancient Hawaiian, a gift from the Honolulu Gas Company, and made of fine old wood, centuries old. Mr. E. C. Jones replied on behalf of Mrs. Jones, and after speaking of the beauty of the gift and the enjoyment of it by Mrs. Jones, said: "May your Pilikia all be Pau and your pleasures Wela Ka Hau," which means, "May your troubles all be over and your pleasures increased." In the bowl was the inscription, "Aloho oe nui" (much love to you). Mrs. O. N. Guldin, of Fort Wayne, spoke for the ladies, expressing the pleasure they had experienced during their visit in San Francisco; she was a charming speaker and was received with great applause.

A dance in the beautiful California Building concluded a day of joy and happiness long to be remembered by all visitors to the Congress.

Friday concludes the sessions of the Congress, with some business and special illumination and fireworks at the P. P. I. E., under the auspices of Mr. Ryan.

[OFFICIAL NOTICE.]

GAS METERS—NEW YORK SECTION—FIRST MEETING.

Season 1915–1916.

The Gas Meeters will have a "get together" meeting on October 21st, at the Hotel Breslin, Broadway and 21st st., New York City. Guests will be welcome. Dinner will be called at 6:30 P.M. sharp.

A. M. BERG, Secy., 1493 Broadway, New York City.

OCTOBER MEETING—NEW YORK SECTION, I. E. S.

The initial meeting of the season of the New York Section I. E. S. will be held Oct. 14, at 8 P.M., at the Engineering Societies Building, 29 W. 39th street. There will be two papers, one by Lieut. McDowell on "Lighting in the Navy," and the other by Capt. Robins on "Use of Light in War." An informal dinner will precede the meeting at Keene's Chop House, 70 W. 36th street, at 6:30 P.M. Members and guests are cordially invited.

NORMAN MACDONALD, Secy.

EDUCATIONAL RALLY.

Members of the Educational Class, in the Brooklyn Union Gas Company, gathered at the Y. M. C. A., Bedford avenue, on Thursday evening, October 7th, to discuss the educational work now under way, and to increase the interest among those not already enrolled.

Mr. T. M. Ambler, Manager of the Commercial Department, had charge of the meeting, and the speaker of the evening was Mr. E. J. Cattell, of Philadelphia. It was evident from the attendance that his fame as an orator preceeded him. All who attended voted this the most successful meeting of its kind they have held.

(*Continued from page 231.*)

Recent Developments in the Doherty Washer Cooler as a Gas Condenser.

the same quantity when heated 0° C. to 85° C. (32° F. to 185° F.) Because of the varying quantity of heat that it is necessary to abstract in order to cool a certain quantity of gas 1° at the different temperatures throughout the cooling, and because of the very small heat removal necessary at low temperatures, considerably less cooling liquor is required to cool a definite quantity of gas between temperatures of long range than through those of short range, when cooling from the higher temperatures.

Plate II. has been constructed to show how this feature affects

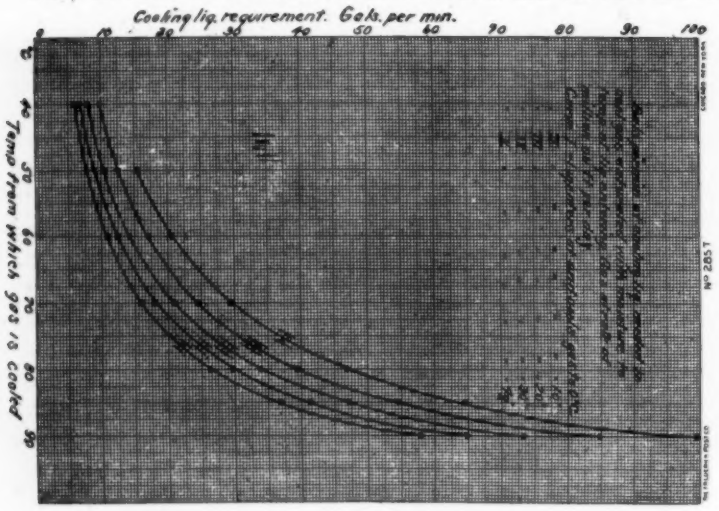


Plate II.

the quantity of cooling liquor required in a washer cooler, to cool gas saturated with moisture to the temperature of the cooling liquor entering the column, with the liquor leaving the column at the temperature of the gas entering. These calculations were made with the assumption that a perfect heat exchange is obtained in the column, and that the maximum cooling capacity of the liquor is utilized; although in practice this is, of course, not obtained. It is easily possible, however, to keep the temperature of the liquor leaving the cooler within 5° C. (9° F.) of the temperature of the gas entering. When cooling from 82° C. to 27° C. (147.6° F. to 48.6° F.) with this difference, the cooling range in the gas extends 55° C. (99° F.), while that of the liquor only 50° C. (90° F.) This reduction of the range, through which the liquor is heated, causes a correspondingly larger quantity of liquor to be used in practice than is shown on the chart, depending upon how closely the gas can be brought to the temperature of the cooling liquor, as the temperature of the liquor leaving is brought closer to the temperature of the gas entering. With the liquor leaving 5° C. (9° F.) below the temperature of the gas entering, under the conditions mentioned above, about 90% of the maximum cooling capacity of the liquor is being used, and the actual circulation required can be calculated from the theoretical by use of this factor.

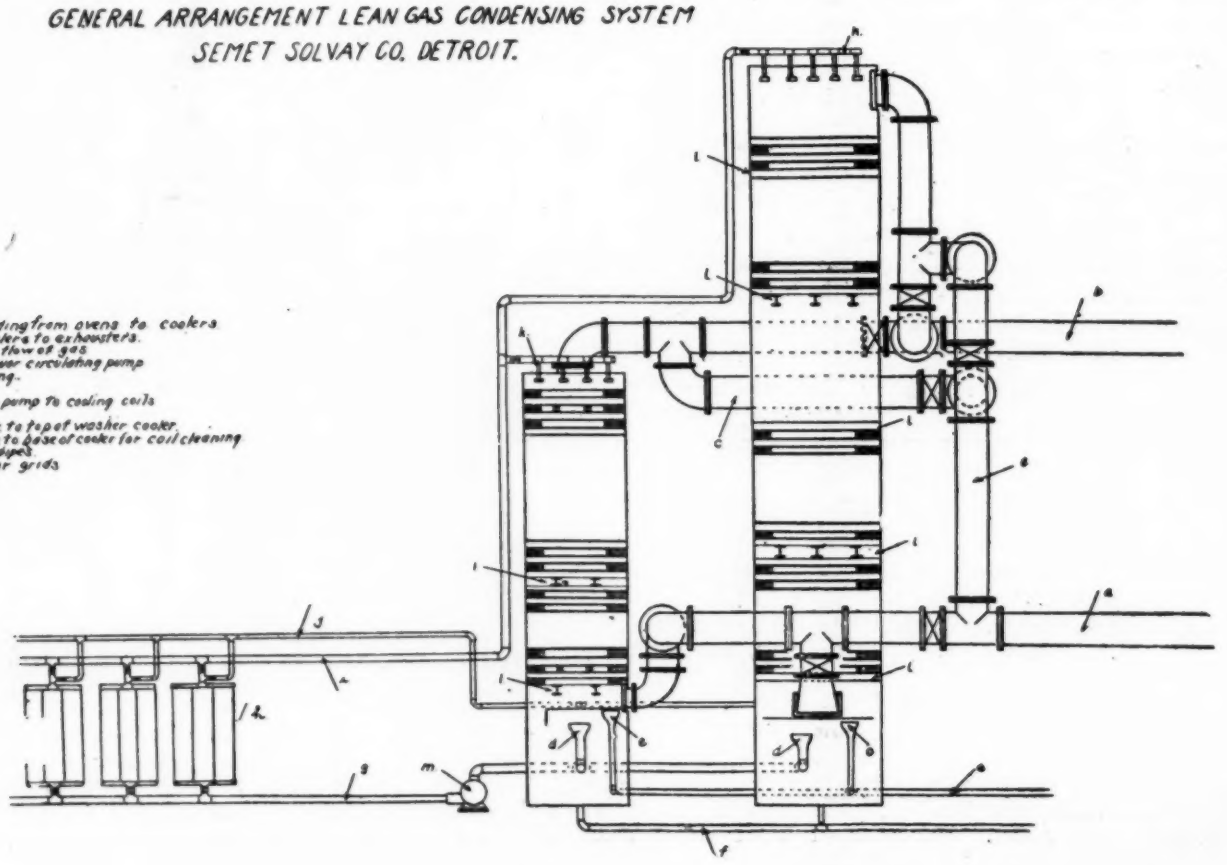
Reference to Plate II. shows that a cooling circulation of 64.5 gallons per minute is required to cool one million cubic feet of gas per day, measured at 0° C. and 760 mm, from 85° C. to 40° C. (184° F. to 104° F.). In this case the cooling liquor would enter the washer cooler at 40° C. (104° F.) and leave at 85° C. (185° F.); or would be heated through a range of 45° C. (81° F.). If the cooling were done between 0° C. and 85° C. (32° F. and 185° F.) by liquor entering at 0° C. (32° F.), a circulation of 37.0 gallons per minute would be sufficient. To cool the came quantity of gas through a range of 85° C. (185° F.) requires only 57.5% as much liquor as is needed when cooling through a range of 45°. C. If this same quantity of gas were cooled from 85° C. (185° F.) to 60° C. (140° F.) by liquor entering at 60° C. (140° F.), a cooling circulation of 85.4 gallons per minute would be necessary.

Let us now consider thermal conditions within the cooler itself. The table shows the quantity and per cent. of heat removed per minute from gas saturated with moisture at 85° C. at the rate of a million cubic feet per day measured at 0° C. and 760 mm., when cooled to lower temperatures.

Temp to which Gas is Cooled from 85° C. (185° F.) Degrees C.	Degrees F.	Heat Removed per minute B. T. U	Per cent. Heat above (32° F.) removed when cooled to Lower Temperature. Per Cent.
80	176	15,386	32.6
60	158	30,288	64.2
60	140	37,320	79.1
50	122	41,205	87.5
40	104	43,517	92.3
30	86	44,984	95.4
28	68	45,952	97.5
10	50	46,614	98.9
0	32	47,122	100.0

As the cooling liquor entering at the top descends through the column it becomes heated, and in turn cools the gas that is passing

GENERAL ARRANGEMENT LEAN GAS CONDENSING SYSTEM
SEMET SOLVAY CO. DETROIT.


a - foul gas piping leading from ovens to coolers
b - gas piping from coolers to exhausters.
c - by-pass to reverse flow of gas
d - suction piping to liquor circulating pump
e - liquor overflow piping.
f - tar draw off piping
g - liquor discharge from pump to cooling coils
h - cooling coils
i - cool liquor return line to top of washer cooler
j - hot liquor return line to base of cooler for coil cleaning
k - liquor distributing pipes
l - I beam supports for grids
m - circulating pump

upward through the column. When cooling a fixed quantity of gas between certain temperatures, with a definite quantity of liquor, it is a matter of simple calculation to show the change in temperature of the liquor as compared with that of the gas. This has been done for a washer cooler when operating under various conditions and the results are plotted on Plate III.

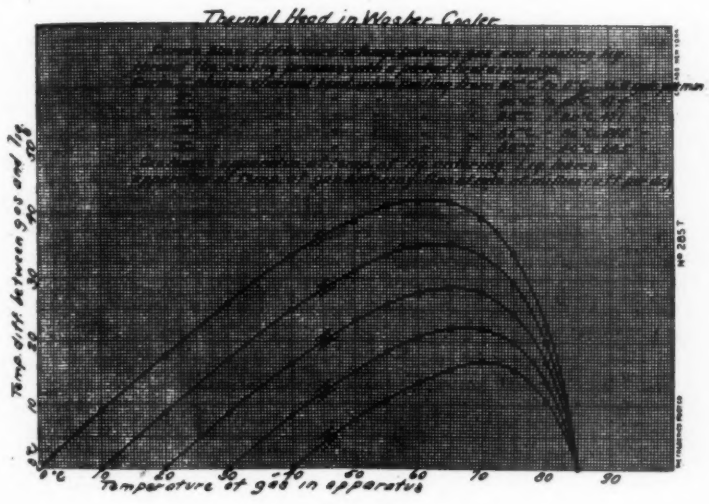


Plate III.

At the top of a cooler working with a perfect heat exchange the temperature of the gas and liquor are about the same. As the liquor flows downward through the apparatus, the thermal difference increases until it reaches a maximum in that part of the apparatus where the gas temperature is from 60° C. to 70° C. (140 to 158° F.), depending upon what range the cooler is working through. With a washer cooler cooling between 20° C. and 85° C. (68° F. and 185° F.), the difference in temperature between the gas and liquor increases from 0 at the top, where the temperature of both the gas and liquor is 20° C. (68° F.), to a maximum of 28.5° C. (83° F.) at that part of the column where the gas is 65° C. (149° F.), and then falls to 0° C. again at the base of the column, where the temperatere of both the gas and liquor is 85° C. (185° F.).

At the Detroit plant the average temperature of the gas entering the coolers runs a little over 80° C. (176° F.), and the cooling problem consists in cooling this gas to a temperature varying from 15° C. (59° F.) in winter to 27° C. (80.5° F.) in summer. As the output increased it became more and more difficult to properly cool the gas, and after a consideration of the above principles, and more especially to relieve stoppages in the secondary lean condenser and secondary rich and lean cooling coils, it was decided to try single stage condensation.

Accordingly, our cooling coil installation was changed from the old two stage system to a new arrangement that allows a straight passage through double pipe cooling coils, and the liquor cooling done in the one operation. The cooling coils are double pipe coolers of the same type as those described by Mr. Blauvelt in 1910. In these the cooling liquor passes through the annular space between a 2″ and 3″ pipe with water passing through the inside of the 2″ and over the outside surface of the 3″.

Since all of the cooling is done in the one washer cooler, very little liquor or condensate separates from the gas at a low temperature. All the condenser liquor leaves at a temperature above 158° F., and is comparatively clean. Our experience has been that the tarry matter and suspended napthalene separate much more readily from liquor at a high temperature than at a low tempera-

Table of Saturated Gases at 760 M.M.s Pressure at Temperatures from 0° to 99° Centigrade.

Calculated by Mr. H. A. Humphrey.

A t°C	B. f = Vapour Tension	C. 760-f	D. 804.6-f / 760-f	E. f / 760	F. 760-f / 760 = (1—E)	G. 760 / 760-f = 760—C	H. GXX
0	4.569	755.431	4.866	.0060	.9940	1.006	1.0060
1	4.909	755.091	5.231	.0064	.9936	1.007	1.0107
2	5.272	754.728	5.620	.0069	.9931	1.007	1 0144
3	5.658	754.342	6.035	.0074	.9926	1.008	1.0191
4	6.069	753.931	6.477	.0080	.9920	1.008	1.0228
5	6.507	753.493	6.948	.0086	.9914	1.009	1.0275
6	6.971	753.029	7.448	.0092	.9908	1.009	1.0312
7	7.466	752.534	7.983	.0098	.9902	1.010	1.0359
8	7.991	752.009	8.550	.0105	.9895	1.011	1.0407
9	8.548	751.452	9.153	.0112	.9888	1.011	1.0444
10	9.140	750.860	9.794	.0120	.9880	1.012	1.0491
11	9.767	750.233	10.475	.0129	.9871	1.013	1.0539
12	10.432	749.568	11.198	.0137	.9863	1.014	1.0587
13	11.137	748.863	11.966	.0147	.9853	1.015	1.0634
14	11.884	748.116	12.781	.0156	.9844	1.016	1.0682
15	12.674	147.326	13.645	.0167	.9833	1.017	1.0730
16	13.510	746.490	14.562	.0178	.9822	1.018	1.0778
17	14.395	745.605	15.534	.0189	.9811	1.019	1.0826
18	15.330	744.670	16.564	.0202	.9798	1.021	1.0884
19	16.319	743.681	17.656	.0215	.9785	1.022	1.0933
20	17.363	742.637	18.812	.0228	.9772	1.023	1.0981
21	18.466	741.534	20.036	.0248	.9757	1.025	1.1040
22	19.630	740.370	21.333	.0258	.9742	1.027	1.1099
23	20.858	739.142	22.705	.0274	.9726	1.028	1.1148
24	22.152	737.848	24.156	.0291	.9709	1.030	1.1207
25	23.517	736.483	25.692	.0309	.9691	1.032	1.1267
26	24.956	735.044	27.318	.0328	.9672	1.034	1.1327
27	26.470	733.530	29.035	.0348	.9652	1.036	1.1387
28	28.065	731.935	30.851	.0369	.9631	1.038	1.1447
29	29.744	730.256	32.772	.0391	.9609	1.041	1.1518
30	31.510	728.490	34.802	.0415	.9585	1.043	1.1578
31	33.366	726.634	36.946	.0439	.9561	1.046	1.1650
32	35.318	724.682	39.213	.0465	.9535	1.049	1.1722
33	37.369	722.631	41.608	.0492	.9508	1.052	1.1794
34	39.523	720.477	44.138	.0520	.9480	1.055	1.1866
35	41.784	718.216	46.810	.0550	.9450	1.058	1.1939
36	44.158	715.842	49.633	.0581	.9419	1.062	1.2023
37	46.648	713.352	52.616	.0614	.9386	1.065	1.2096
38	49.259	710.741	55.764	.0648	9352	1.069	1.2181
39	51.996	708.004	59.090	.0684	.9316	1.073	1.2266
40	54.865	705.135	62.604	.0722	.9278	1.078	1.2363
41	57.870	702.130	66.316	.0761	.9239	1.082	1.2448
42	61.017	698.983	70.237	.0803	.9197	1.087	1.2545
43	64.310	695.690	74.378	.0846	.9154	1.092	1.2643
44	67.757	692.243	78.755	.0892	.9108	1.098	1.2753
45	71.362	688.638	83.379	.0939	.9061	1.104	1.2863
46	75.131	684.869	88.265	.0989	.9011	1.110	1.2974
47	79.071	680.929	93.432	.1040	.8960	1.116	1.3085
48	83.188	676.812	98.895	.1095	.8905	1.123	1.3208
49	87.488	672.512	104.672	.1151	.8849	1.130	1.3332
50	91.978	668.022	110.783	.1210	.8790	1.138	1.3468
51	96.664	663.336	117.250	.1272	.8728	1.146	1.3605
52	101.554	658.446	124.096	.1336	.8664	1.154	1.3742
53	106.655	653.345	131.347	.1403	.8597	1.163	1.3892
54	111.973	648.027	139.027	.1473	.8527	1.173	1.4054
55	117.516	642.484	147.168	.1546	.8454	1.183	1.4218
56	123.292	636.708	155.803	.1622	.8378	1.194	1.4394
57	129.310	630.690	164.967	.1701	.8299	1.205	1.4571
58	135.575	624.425	174.695	.1784	.8216	1.217	1.4761
59	142.097	617.903	185.031	.1870	.8130	1.230	1.4963
60	148.885	611.115	196.023	.1959	.8041	1.244	1.5179
61	155.946	604.054	207.720	.2052	.7948	1.258	1.5396
62	163.289	596.711	220.178	.2149	.7851	1.274	1.5639
63	170.924	589.076	233.460	.2249	.7751	1.290	1.5883
64	178.858	581.142	247.632	.2353	.7647	1.308	1.6152
65	187.103	572.897	262.775	.2462	.7538	1.327	1.6436
66	195.666	564.334	278.971	.2575	.7425	1.347	1.6733
67	204.559	555.441	296.320	.2692	.7308	1.368	1.7044
68	213.790	546.210	314.925	.2813	.7187	1.391	1.7381
69	223.369	536.631	334.909	.2939	.7061	1.416	1.7746
70	233.308	526.692	356.413	.3070	.6930	1.443	1.8137
71	243.616	516.384	379.588	.3205	.6795	1.472	1.8556
72	254.305	505.695	404.619	.3346	.6654	1.503	1.9002
73	265.385	494.615	431.707	.3492	.6508	1.537	1.9488
74	276.868	483.132	461.091	.3643	.6357	1.573	2.0002
75	288.764	471.236	493.043	.3800	.6200	1.613	2.0570
76	301.086	458.914	527.885	.3962	.6038	1.656	2.1179
77	313.846	446.154	565.994	.4130	.5870	1.703	2.1843
78	327.055	432.945	607.810	.4303	.5697	1.755	2.2574
79	340.726	419.274	653.864	.4483	.5517	1.813	2.3386
80	354.873	405.127	704.793	.4669	.5330	1.876	2.4268
81	369.508	390.492	761.363	.4862	.5138	1.946	2.5245
82	384.643	375.357	824.505	.5061	.4939	2.025	2.6344
83	400.293	359.707	895.384	.5267	.4733	2.113	2.7566
84	416.472	343.528	975.447	.5480	.4520	2.212	2.8939
85	433.194	326.806	1066.528	.5700	.4300	2.326	3.0516
86	450.473	309.527	1170.982	.5927	.4073	2.455	3.2298
87	468.324	291.676	1291.890	.6162	.3338	2.606	3.4381
88	486.764	273.236	1433.377	6405	.3595	2.781	3.6792
89	505.806	254.194	1601.027	.6655	.3345	2.990	3.9666
90	525.468	234.532	1802.703	.6914	.3086	3.240	4.3102
91	545.765	214.235	2049.724	.7181	.2819	3.548	4.7329
92	566.715	193.285	2359.101	.7457	.2543	3.932	5.2596
93	588.335	171.665	2757.548	.7741	.2259	4.428	5.9393
94	610.643	149.357	3289.590	.8035	.1965	5.088	6.8433
95	633.657	126.343	4035.368	.8338	.1662	6.015	8.1121
96	657.396	102.604	5155.168	.8650	.1350	7.407	10.0166
97	681.879	78.121	7022.950	.8972	.1028	9.729	13.1924
98	707.127	52.873	10760.774	.9304	.0696	14.374	19.5438
99	733.160	26.840	21978.410	9647	.0353	28.316	38.6041
100	760.			1.			

A = Temperatures in Degrees Centigrade.
B = Vapor Tension of Water Vapor in Millimeters of Mercury at Various temperatures.
C = 760-B.
D = Grams of Water absorbed by 1 Ms Dry Gas at 0° when saturated at various temperatures and 760 MM. pressure.
E = Percentage of Water Vapor in a saturated mixture of Gas and Water Vapor at various temperatures and 760 MM. pressure.
F = Percentage of Dry Gas in a saturated mixture of Gas and Water Vapor at various temperatures and 760 MM. pressure.
H = Total volume at 760 MM. pressure of a mixture of Gas and Water Vapor resulting from saturating 1 volume of Dry Gas at 0° to various temperatures.

ture. Because of the higher temperature at which the liquor separates from the tar in the single stage system, the liquor going to the cooling coils is much cleaner than it was when coming from the secondary condenser with the two stage system. This has resulted in much less trouble with napthalene deposits in the cooling coils.

The washer coolers used in this service until recently, were the old primary coolers described by Mr. Blauvelt, with an additional 5 feet of gridding added. One of these coolers has been used for the lean gas and one for the rich. Since the capacity of the plant was increased to more than 2,000 tons daily, the lean cooler has been overloaded during summer weather, and a new unit has been built to handle the gas, the old one being retained as a spare, to be used when the new cooler is being cleaned. This new washer cooler has been designed to allow a maximum heat absorption by the cooling liquor, and to bring the temperature of the gas leaving to the temperature of the liquor entering the column. The general arrangement of the lean cooling system is shown on the diagram on page 234.

This new washer cooler was only erected during the past summer, and has not been in run sufficiently long to present any accurate data from its operation. The old coolers, as single stage washers, have given very good results when not overloaded, and have verified the conclusions reached theoretically from the tables.

With single stage condensation as practiced in Detroit, all the tar removed from the gas in the condensers is removed from contact with the gas at the highest temperature that exists within the condensing system. It also seems that with the new single stage cooler the condensing process is conducted in as short a time as our present knowledge and equipment will allow. On page 15 of the Proceedings of this Association for 1911 is the following statement by Prof. A. H. White and R. S. Tour: "Would the candle power or heating value be injured by rapid cooling? The answer is quite certain that they would not. The more benzol retained in the gas the better. The quicker the tar is removed from the gas, and the higher the temperature at which it is removed, the better will be the candle power and heating value of the gas." The experience, to date, at the Detroit plant bears out this statement.

To sum up, the substitution of single stage for double stage condensation has allowed the separation of all the condenser tar at a point of highest temperature, and in an extremely short time, It has permitted the elimination of two washer cooler units from our condensing system, and a corresponding reduction in the pumping equipment. The same pumps that previously provided the primary circulation, took care of the single stage coolers even with the increased load until tne construction of the new lean washer cooler with its increased height. The use of steam has been eliminated for coil and apparatus cleaning, its function now being performed, as a matter of routine, by the heat and tar carried by the crude material itself. And finally the move has been a simplification, and has resulted in a clearer understanding of the apparatus and its operation by the operating force; which has reacted to give more uniform and more satisfactory results.

Accounting.

[Paper by P. S. YOUNG to the International Gas Congress.]

Starting with the assumption that the Congress is familiar with the American Gas Institute's uniform system of accounts, or some one of the systems that have been adopted by utility commissions in the United States, which are in harmony with it, it is unnecessary to state at any length the important functions which such accounting systems perform. Primarily, they are designed to explain and control the business operations of a gas company, including, as these operations do, the financing, construction, manufacture, distribution, selling, collection, purchasing, disbursement and other transactions connected with the management. To a certain extent the measure of this control is the measure of their efficiency.

An elaborate system of accounting is not necessarily indespensible for accurate information of the operations and financial condition of a gas company. Simplicity is a necessity, especially for the busy executive who must concentrate his attention on the essentials, and who must not be diverted from his object by having to sift them out from among a mass of interesting but, for this purpose, irrelevant statements of facts. Accounting is done for the purpose of assuring proper return for service rendered, to safeguard the outlay, control costs develop efficiency, give information as to profits, and to present at periodical intervals the true financial standing of an enterprise. Its use, however, can be made more far-reaching. It should not be restrictive in its functions, but should be suggestive and give direction to an enterprise. Without doubt the commercial development of the gas industry has been largely promoted by intelligent accounting. This is especially marked in those companies that have made the most intensive effort in sales promotion.

The operative control of companies widely separated geographically, would never have reached its present proportions without the aid of comprehensive accounting systems. This bringing together, for comparison, of separate corporate units, with their various costs of construction, manufacture, distribution, collection, selling, purchasing, etc., has resulted in efficiencies that might otherwise never have been obtained.

It should be recognized that accounting must be constructive to be of the greatest service to gas companies, and elastic and adaptable to the needs of those responsible for the conduct of an enterprise. The gas industry, many years ago, departed from the receipt and expenditure systems of recording its transactions, but a system providing for income statements and balance sheets, without contemplating cost analyses and comparisons with proper standards, is not very much in advance of such a system.

There is a considerable element of protection to gas companies in the adoption of standardized methods of accounting, especially in regard to their relations with governmental bodies and the public generally. A management must not only have the confidence of the stockholders of the company and of its employees, but it must have the confidence of the public. This confidence can best be won by a comprehensive presentation, periodically, of all the facts of the business, stated in relation to other known facts. A management with these facts at its disposal can, with assurance, claim its proper place with other productive enterprises in any community in which it may operate.

To increase accounting efficiency we must both improve the methods and improve the men charged with the application of them. It would seem possible to further standardize accounting systems having to do with the various operations of a gas company. It would be desirable to reduce as many of the accounting processes as possible to a routine, though, of course, the principles governing them, and the objects to be obtained, must always be kept clearly in mind by those responsible for the work. Accounts should embody the relation between actual and ideal results. Standards should be developed and kept constantly in line with conditions. All definitions of terms should be agreed upon, and all practices in methods of accounting, selling, organization and procedure should be standardized as far as possible. The accounting employee should be given every opportunity to acquire experience in each department or activity of the gas company. When employed he should have proper grounding and sufficient education to form a foundation upon which to build his business training. The opportunity should be given every accounting employee to obtain the necessary training to develop him into a competent and enthusiastic worker. The organization should be so arranged that avenues for promotion are provided, and the peculiar qualifications of the individual should receive consideration in this arrangement.

In accounting work it is possible to be accurate in statement, and yet misleading. Too often has the reputation of accountants suffered, because of failure on the part of a management to appreciate the obvious deduction from statements of facts presented, without proper interpretation. An accountant must learn to present things in a form to be readily understood and to keep his technique in the background, for, though he may be somewhat vain of his accomplishments, they will be counted against him if they have interferred with his simplicity of statement.

The accountant can find a great field of usefulness in studying the problems surrounding the promotion of new business. This question alone is one that will require all his business experience and technical knowledge for its proper solution; and the larger problems too, that follow in the train of regulation, must be studied by him, for the conduct and standing of an enterprise must be considered in the light of the principles governing the application of regulation to public utility corporations.

From this cursory glance at the accounting of a gas company, and at the opportunity for the accountant therein, it is certainly plain that there remains much to be done that can be of value to the gas industry through the improvement and standardization of accounting methods, and in raising the standard of accounting employees of gas companies by encouraging them to do better work, by opening avenues of promotion and furnishing them with the opportunity to acquire the requisite training.

Publications.

[All Publications, Catalogues, etc., mentioned below, are kept in our office for the convenience of our patrons.]

Defeating Rust.—A booklet by The American Rolling Mill Co., Middletown, O., tells about the "best rust-resistant metal made from iron ore," known as American Ingot Iron, and on the market under the trade name "Armco iron." It can be had in sheets, plates, boiler tubes, rivets, pipe and trough, metal lath, fence wire, and all forms of roofing. It resists corrosion to a high degree, especially the action of such gas as sulphur, ammonia, etc., that gas engineers are troubled with around their plants. In the booklet are described the many uses to which Armco Iron has been put, illustrating applications where it has been successfully used.

Safety First—With the Youngstown Sheet and Tube Company, Youngstown, O. This booklet gives the history of the "Safety First" organization maintained by this company: and the "Safety" devices employed by the company are described and illustrated, with construction ideas on safeguarding the life of employees.

The Testing Service of the Electrical Testing Laboratories, Inc.—This book describes the equipment, organization, and work of the Electrical Testing Laboratories, Inc., New York, with illustrations of their apparatus with which to conduct the work and perform all manner of tests. The tests made at these laboratories cover all kinds of materials and apparatus.

Good Furnaces Made Better.—Armstrong Cork and Insulating Company, Pittsburgh, Pa. The little booklet, under the above caption, describes nonpariel insulating brick, manufactured by the company; a valuable material for boiler and furnace walls.

Interesting Installations.—The Improved Equipment Company, New York. A little booklet illustrating and describing briefly the erection by the company of several benches of retorts in an important gas plant.

Advertising Aids for the Busy Gas Man.—William M. Crane Company, New York. The booklet begins with a short talk on advertising; and in the pages that follow are some good advertising suggestions for gas appliances, prepared for the busy gas man. They are appropriate for use in the daily papers, and a large collection of cuts are illustrated, which the company is prepared to furnish free on request. It will pay every gas man to have a copy of this booklet on his desk.

Sterling Low Pressure Governor, Bulletin 9 A.—Connelly Iron Sponge and Governor Company. This booklet describes the low pressure governor manufactured by the company, designed to automatically control the pressure of the gas in all installations for industrial and commercial uses. It is recommended for use with incandescent lighting, gas ranges, gas engines, linotype machines, annealing and brazing furnaces, japanning and lacquering ovens, and wherever a uniform supply of gas is desired. A complete description of the governor is given.

Sprays for Cooling Condensing Water.—Bulletin No. 101. The Spray Engineering Company, Boston, Mass. This gives a description and details of installations for cooling waters for condensers and transformers, or water jackets. In the contents are found some data on tests, and several installations where the spray system for cooling water is used are illustrated.

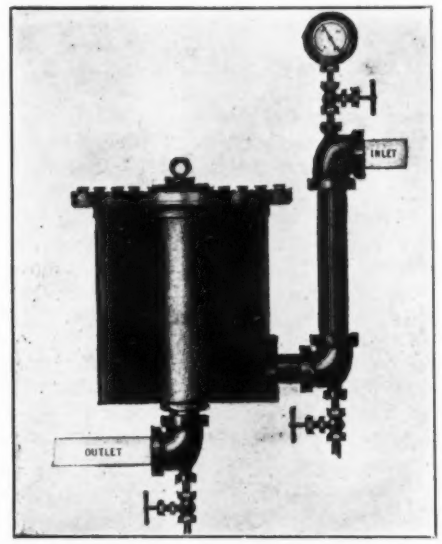
Washing and Cooling Air for Steam Turbine Generators.—Bulletin No. 151. The Spray Engineering Company, Boston, Mass. Contains a brief description of the application of a spray air washer and cooler, where water is used as the agent, in supplying cooled air for electric generators.

Oil Displaces Coal.

Owing to the great output of petroleum in California and its use as a manufacturing, railroad and steamer fuel, the production of coal in Washington has been considerably reduced during recent years. It is estimated that the consumption of California oil for fuel on the Pacific Coast is equivalent to about 21,000,000 tons of coal, or between six and seven times the output of coal in Washington, or for that matter in all the Pacific Coast States combined, in 1914.

New Methods and Appliances.

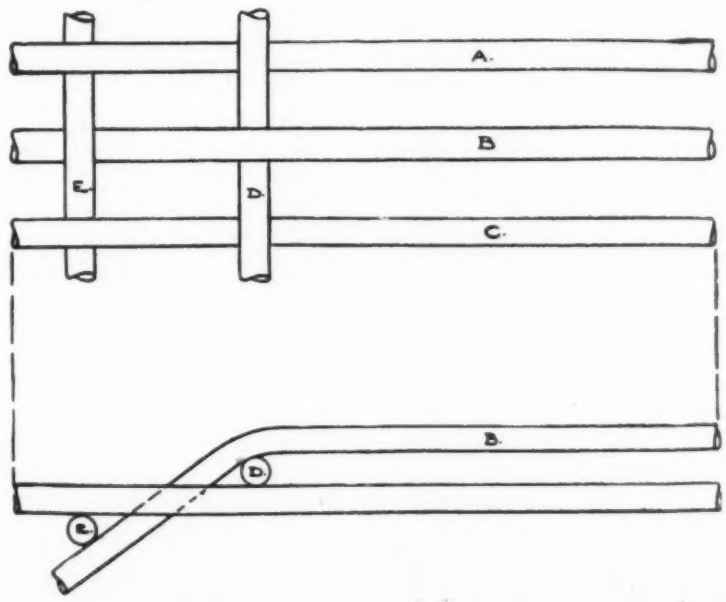
Removing Oil from Feed Water.—The purpose of The Deoleizer is to take out oil; all other devices are some form of filter depending upon mechanical interception, are generally blankets, discs, baskets, trays, nettings, cartridges, etc., made of or filled with various kinds of filtration materials, such as hay, felt, excelsior, towelling, etc. The theory seemed to be that a sand or charcoal filter that would remove mud or visible impurities from water, would be too coarse in its voids to intercept the minute suspended atoms of oil; hence it was thought that the substitution of some finer mesh like felt or loose woven textile would be a more efficient strainer. It has been found, however, that straining will not remove all of the oil.



The Deolizer discards the idea of mechanical filtration or straining, and depends for its effectiveness upon the affinity for oil of a newly discovered material; an affinity analogous to that of dry cement for water. The material resembles granulated charcoal or old-fashioned gun powder, but is, however, strictly mineral in its nature and substantially indestructible.

The record of the apparatus by the ether test is the removal from an emulsion of 9,999,994 parts of oil in 10,000,000; the oil remaining equal to approximately one drop in one and a quarter barrels of water. The Deoleizer, therefore, permits all condensation to be returned to the boiler over and over again, with absolute safety. The resultant saving is 90% of the feed water bill, a saving in coal due to the elimination of scale, no expense for boiler compound, and an end to the nuisance of cleaning boilers, no burned tubes or blistered plates.

Making Cold Bends in the Field.—The accompanying drawing is self-explanatory, showing a useful field method of bending 3, 4 and 6″ pipe.



ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. HENRY WHARTON, for over 31 years connected with the Westmoreland Coal Co., and its allied interests in various capacities, and serving as Secretary of the company for the past 10 years, has resigned. Mr. Wharton has become President of the Montrose-Pocahontas Coal Co., recently organized in West Virginia. The company have opened temporary offices in the Drexel Building, Philadelphia, but Mr. Wharton announces he will open very shortly, an office for the sale of gas coal and other coals. The many friends of Mr. Wharton will wish him the best of good luck.

AT the close of each fiscal year the books of the Boston Consolidated Gas Company are audited to ascertain the cost of gas per 1,000 feet, in conformity with the provision of the legislative act relating to the sliding scale of gas prices. The audit for the year ended June 30, 1915, just completed, show average cost of gas per 1,000 feet in comparison with previous years as follows (in cents):

Cost	1915	1914	1913	1912	1911
Gas made*.....	26.31	30.14	24.95	22.73	23.27
Gas bought*.....	29.97	29.95	29.89	29.89	29.93
Gas made and bought*..	28.25	30.04	27.38	25.97	26.22
Gas sold.....	28.83	31.06	28.31	26.89	27.13
Distrib. and gen. exp....	20.33	21.46	20.56	21.36	22.01
Total cost.	49.16	52.52	48.87	48.25	49.14

* In holder.

The total cost in 1909–1910 year was 48.57 cents, in 1908–1909, 52.72 cents, in 1907–8, 55.64 cents. The quantity of gas made, puschased and sold in cubic feet by the Boston Consolidated Gas Company in the past 6 years, compares as follows (000,000) omitted:

	1915	1914	1913	1912	1911	1910
Made.....	2,957	3,140	3,094	3,159	3,052	2,912
Bought.....	3,320	3,153	2,996	2,612	2,425	2,274
Total out.....	6,277	6,293	6,090	5,771	5,477	5,191
Gas sold.....	6,152	6,086	5,891	5,574	5,294	5,037

RAY PIATT, who for some time has been the right hand man of Manager Ingle of the Perry (Ia.) Gas Works, has recently accepted a position as superintendent of the municipal plant at Dexter, and has entered upon his duties.

THE Stone & Webster Engineering Corporation, constructing engineers, is circulating a very handsome booklet of the coal gas plant of the Fall River (Mass.) Gas Company. A panoramic photograph of the plant is one of the features; other views show the plant during construction, looking north from Charles street, erecting coal conveyor leading from wharf to retort house at right, construction work on the coal wharf, looking southwest from foot of Birch street, the coal wharf looking west from the railroad track, the retort house, the retort house coke conveyor, coke bunker and monorail system, looking southeast from water front, the retort house charging floor, top of producers and front of producers, the purifier boxes, with capacity of 2,000,000 feet per day, condensing system, 1,000,000 feet capacity, and the laboratory in the meter house. It is an artistic description of a wonderful plant.

THE Illinois Public Utilities Commission has ordered the St. Clair County Gas and Electric Company, to lower gas rates to citizens of Belleville, from $1.15 to $1 per 1,000 cubic feet.

FRANKLIN J. ELY, former purchasing agent for the Peoples Gas Light and Coke Co., Chicago, died last week at Watkins Glen, N. Y. He was born in Milwaukee in 1874, and was a graduate of Yale University in the class of 1897. Mr. Ely had been an employee of the gas company for several years, and resigned only a few months ago on account of failing health. He is survived by his widow and two sons, and by his mother, Mrs. Oliver Curtiss Ely, and two sisters, Mrs. Benjamin F. Ells of Rockford, Ills., and Mrs. Sherman H. Bouton of Chicago.

ON January 1, 1915, there were 2,666 miles of streets and 10 square miles of parks to be lighted in Greater New York, and there were in all of the boroughs, approximately 42,000 electric lamps and 45,000 gas lamps.

AS a sequel of the many troubles experienced with the gas company, the La Salle (Ills.) city council has voted to have its attorney draw up an ordinance that will annul the franchise of the utility corporation. Residents of all parts of La Salle have long complained against the service furnished them, but without result, and as a last resort, in an effort to bring the gas company to terms, the annulment proposition was taken up and passed by the city council.

A NEW White Way will be established in the residence districts of St. Louis, Mo., as a demonstration of artistic lighting with gas. The new lights will be installed on Lindell Boulevard, from Grand avenue to Kingshighway, and on Kingshighway from Washington boulevard to Hortense place. A permit has been issued by the Board of Public Service for the installation by the Welsbach Street Light Company of America, which has the contract to light the city streets. The new system will be established without cost to the city and will become a part of the permanent lighting effect. The present lighting contract will expire in 1920, and the Laclede company, by installing the new display, expects to show how gas lighting service has improved in recent years, and what changes may be made if the gas lighting contract is renewed.

THE largest sale of gas in 24 hours in the history of the Rochester (N. Y.) Railway and Light Company, was made Tuesday, April 21st, 6,000,000 cubic feet. For two weeks the consumption of gas has been tremendous. "Housewives surely are canning stuff this year," said Assistant General Manager Herman Russell, as he looked over his gas sales. "There will be no starving this winter, for every available can will be filled with tomatoes, cucumbers, pickles, and all manner of preserves and jams and jellies. A year of cheap fruit always means much canning, and much canning means large consumption of gas, for housewives have learned that gas is quicker, cheaper and more convenient and comfortable to use for this purpose. And the cool weather also has added to the consumption of gas."

ARTHUR B. CURTIS, chief complaint investigator; William F. Doolittle, correspondent; F. A. Brewald, general supervisor of the collection department; C. B. Walker, the general bookkeeper; Andrew Gallagher, the chief bill clerk; Reid Cameron, special solicitor; William Buttner, engineer; C. O. Frary, special solicitor; William Longstreet, chief clerk of the meter readers department, and E. M. Sullivan of the arc light department, constituted the group from the Peoples Gas Light and Coke Company who were in camp at Fort Sheridan. While there they drafted, adopted, signed and sent resolutions expressing their thanks, gratitude and loyalty to their employers.

H. J. DUNBAUGH, representing the Public Service Company of Northern Illinois, recently appeared before the State Public Utilities Commission to explain the company's application for authority to use preparment meters in Evanston. He explained that the gas rate in Evanston was figured on a block scale, $1 for the first one thousand feet, 90 cents for the next two thousand feet, and 80 cents a thousand for the remainder, and that there was a minimum charge of 75 cents. "We have a few prepayment meters in use in Evanston," he said, "and these are set at $1 a thousand feet. This is contrary to a recent ruling of the commission, which provided that the same rate for gas shall be charged through a prepayment meter as through a regular one; but practically all the customers using prepayment meters desire to keep them, and that is the reason for our application. We desire to please our customers, but no more prepayment meters will be installed.

IN case the private telephone line, built by the Empire Gas and Electric Company, connecting its six plants, is put out of commission by storms or other causes, the plants at Auburn and Geneva, and eventually all the stations, will be able to communicate by wireless telegraph. The work of erecting the apparatus is in charge of Lewis C. Reynolds, general superintendent of the company, and the plants will be in wireless communication before the holidays. Several employees of the company have become proficient in the use of wireless apparatus, in an amateur way, and others will be instructed. The wireless will be used to supplement the telephone lines, and will connect the operating plants and the offices of the company.

THE Pacific Gas and Electric Company has completed another section of its new big gas main from Santa Rosa to Petaluma, Cal., having now reached a point below Cotati. The section just completed is 5 miles, and makes about 8½ miles of new maines already built, and in the near future the entire main into Petaluma will be completed. The section added means better service and a noteworthy improvement.

THE annual report of the Baltimore Consolidated Gas, Electric Light and Power Company, says: "A careful investigation was undertaken during the year to determine the industrial users of gas that could be secured under a schedule of rates that automatically adjusts itself to a large range of industrial uses. Such a schedule was adopted in April, and promises to be productive of important manufacturing acquisitions to the city." The company has contracted for an additional 3,000,000 cubic feet of coke oven gas, making the total quantity of coke oven gas 7,400,000 cubic feet a day.

EXTENSIVE improvements are in progress at the gas plant of the Canton (Ill.) Gas and Electric Company. A new steel roof is being put on the retort house, and a brick wall is being erected along the east side, enlarging the house. Obstructions have been removed from the rear of the benches, and the whole building is being made fireproof.

THE Chicopee (Mass.) Electric Light Commissioners have appointed John Benedict, former commercial agent of the Athol Gas and Electric Company, manager of the Chicopee municipal electric light plant. C. W. Whiting, advisory manager of the plant, who is conducting an investigation of its affairs, will remain there until his work is completed, and Mr. Benedict will work under him.

FROM the Detroit, Mich., "News": "That other big employers of labor besides Henry Ford, has discovered that the welfare and training of employees is profitable in dividends, was the declaration of O. L. Palmer, of the Detroit City Gas Company, 'We should do everything in our power to encourage the men in pursuit of knowledge, even if it be no more than teaching them to play the saxaphone,' continued Mr. Palmer, 'When our men wanted to organize a band we were glad to help them do it. By so doing we have tied the men more closely to the company and have aided their development along right lines.' Mr. Palmer went on to say that the Detroit City Gas Company had recently inaugurated a plan of education for their men, in co-operation with the technical institute of the Detroit Y. M. C. A. The men are encouraged to attend the institute, and when they can show a certificate of completion of any of the courses, the company refunds them the amount they have paid for tuition and other expenses. 'We just paid $175 to a man who had finished a course, and we consider the money well laid out,' continued Mr. Palmer. 'It will come back to us in better service and figure as a factor in increased efficiency of the plant.'"

IT is reported that the Pacific Gas and Electric Company, owning the car system in Sacramento, Cal., is about to establish a jitney service to compete with the independent jitney busses now operating in that city. The report say that the company has arranged to purchase 50 automobiles—Fords—for the purpose. The company denies the report and no one seems to affirm it authoritatively.

CHARLES P. CUSHMAN, representative in Japan of the Anthony N. Brady estate, died at the Hotel Biltmore, New York city, Tuesday of last week. He came to New York six weeks ago on business, and had planned to sail this week for Japan. Mr. Cushman has been Eastern representative for the Brady interests for about nine years. He was manager of the city gas works of Osaka, and director of other enterprises in Japan. He was a supporter of the policy of Japanese interference in Chinese affairs on the ground that it was a good thing for America, because Japan would have to buy from this country the raw materials for products to be sold in the new fields opened to her manufacturing trade. Mr. Cushman was born in Lisbon, N. H., forty-eight years ago, and was graduated from Dartmouth. He was a lawyer by profession, and for several years before entering the employ of the Brady estate was an offlcial of the People's Gas Company of Chicago. He was not married. Mr. Cushman is survived by his father, George F. Cushman of Lisbon; a sister, Miss Ellen M. Cushman of Montclair, N. J., and two brothers, Harry O. Cushman, of Boston, and James M. Cushman, of Des Moines.

UTILITIES COMMISSION NEWS.

ILLINOIS COMMISSION APPOINTMENT.—Mr. J. H. Prior heretofore assistant engineer, has been appointed chief engineer of the State Public Utilities Commission of Illinois.

Mr. Prior was educated at the Armour Institute of Technology and the University of Chicago, and was engineer of design of the Chicago, Milwaukee & St. Paul Railway from 1905 to 1914. In 1906 and 1907 he made valuations of all that company's structures in the States of Minnesota and South Dakota, required by the railroad regulatory and taxing bodies of those States. He is a member of the American Society of Civil Engineers; and has been, from time to time, an officer of the Western Society of Engineers.

The following appreciation is sent us by one of his associates:

"The personnel of a State Regulatory Commission is no less important to gas men than the laws and rules under which such a body operates, and next to the commissioners themselves, the most important position is that of chief engineer, because he is, to a certain extent, the intermediary between the companies and the commissioners. If he is hard to meet, and difficult to talk to, it makes the carrying on of negotiations much more difficult than where he is ready and willing to personally hear complaints, suggestions and petitions. Further, when a formal complaint is filed, and the engineers of the Commission start on an inventory or appraisal of the property, the chief engineer can lighten the burden on the commission, the company, and the municipality to a marked degree, without in anyway sacrificing his authority, or making himself or the commission open to criticsm.

"In other words, in any rate case there should be no doubt concerning the amount of property, or the propriety of including it in the invensory, although there may be grounds for difference in the values to be assigned to the units. By informal conferences, and open discussions between the engineers of a commission and those of the company, it is generally possible to go before the commission for formal hearings with the testimony in such form that minimum time, expense and worry is caused all parties. To do this without creating suspicion calls for a great deal of tact on the part of the chief engineer, and there are other ways in which his attitude and capacity have great influence for good or harm in the conduct of work in connection with a State Utility Commission.

"In nearly all cases informal complaints—the microbes that breed rate cases unless they are handled with care—are assigned to the engineering department. If they are handled careless everybody connected with them will get sore, and before anybody is aware of the drift of things, gangrene has set in, and it becomes a case for the State, with the knife of the surgeon required to remove the disorder. In some cases the operation is successful—but the patient dies or remains a chronic invalid.

"It is for reasons such as outlined above, and for others that need not be enumerated, that gas men will be interested in noting the appointment to the long vacant post of Chief Engineer to the Public Utilities Commissior of Illinois, has just been filled by the elevation of Mr. J. H. Prior from assistant to chief.

"This little notice is an appreciation by one who has worked with Mr. Prior for a considerable time. It is not inspired, but is written for the information of gas men interested in the outcome.

"Joseph H. Prior possesses tact and courtesy in a marked degree, and this, united with initiative, with a splendid knowledge of men, and the ability to recognize merit and worth in his assistants, make his appointment an ideal one from the standpoint of gas men in Illinois, and elsewhere, because the possibilities for good or harm in the chief engineer of any State utility commission cannot be limited to the State in which he operates.

"Mr. Prior's experience has been principally in the engineering departments of important railroads, and as they are perhaps the most important public utilities in any State, it seems well to have as chief engineer a man thoroughly familiar with their operation.

"Gas men in Illinois will be glad to know that the new chief engineer is 'above suspicion.' He has the knack of getting the men under him to work hard and long, and he does not try to run the whole department himself. He believes in specialization, and for that reason gas men may feel that engineering problems before the commission will be handled by a gas engineer, under the direction of an able chief engineer who can direct with a minimum of interference. Mr. Prior's appointment was made 'on merit,' and there is every reason to believe it will be satisfactory to all concerned."

Financial Notes.

EARNINGS of subsidiaries of UNITED GAS AND ELECTRIC CORPORATION are steadily improving, as shown by their gains for the first seven months of 1915. August 1, 1915, all subsidiaries had 128,373 gas meters in use, a gain of 7,797, or 6.45%, over the first seven months of 1914; there were 107,388 electric meters in use, a gain of 11,260, or 11.7%; connected load in motors was 132,966 horsepower, a gain of 14,355, or 12.1%. In the first seven months of 1915 the companies installed 14,846 gas ranges, a gain of 61.75% over the number installed in the first seven months of 1914, and sold 2,661 water heaters, an increase of 28.2%. Houston Light and Power Company attached over 300-horsepower in contracts in July alone. Lockport Light, Heat and Power Company, the Colorado Springs Light, Heat and Power Company, the Wilkesbarre Company, the Consumers Electric Light Company of New Orleans and other subsidiaries are securing many new power contracts. The districts in which these companies operate are now showing material gains in industrial activity. The street railway subsidiaries are recovering from jitney competition. In Memphis, as well as in Birmingham, the situation has improved greatly, and earnings of the street railways are coming back. Other street railway properties are showing improvement.

THE AMERICAN GAS COMPANY has declared its quarterly dividend of 2%, payable December 1, 1915, to stockholders of record Nov. 17, 1915.

THE AMERICAN LIGHT AND TRACTION COMPANY has declared a cash dividend of 1½%, on preferred stock; 2½% cash dividend on common stock, and a dividend at the rate of 2½ shares of common stock on every 100 shares of common stock, all payable November 1, 1915.

A QUARTERLY dividend, at the rate of 9% per annum, amounting to $1.12½ per share, has been declared on the capital stock of the HAVERHILL GAS LIGHT COMPANY, payable Oct. 1, 1915.

KANSAS GAS AND ELECTRIC COMPANY, quarterly, 1¾% on preferred, is payable Oct. 1, to holders of record Sept. 25. August showed net earnings of $31,712, as against $30,972 in 1914.

THE accumulation of PEOPLE'S GAS LIGHT AND COKE COMPANY stock that has been going on quietly in both Chicago and New York markets, has been traced very close to the management. The company is doing well in point of gross business and net profits, the decreases of the early part of the year having been offset some time ago, and the business now assures a fair margin of surplus over all requirements for the current fiscal year. Talk of price regulation and other matters incident to such proceedings, is not causing the management apprehension. A director is credited with having told banker friends that present dividend rates will not be disturbed.

STOCKHOLDERS of the CONSOLIDATED GAS, ELECTRIC LIGHT AND POWER COMPANY have received copies of the annual report for the twelve months ended June 30, showing an increase in both gross and net income as compared with the previous fiscal year. The total gross income for the year was $6,789,401.87, a gain of $338,505,76, or 6.1%. Operating expenses and taxes were $3,576,583.14, while net earnings were $3,212,818.73, a gain of $145,744.01, or 4.8%. Fixed charges for the year were $1,640,361, leaving a net income of $1,572,457.42. Dividends paid amounted to $1,064,628.89, leaving a surplus of $507,828.53. The reserve for depreciation, amortization, etc., totaled $460,000, while the net surplus (reserved for contingencies) amounted to $47,828.53. In connection with the operating expense account, the company explains that the amount does not include new business expenses and extraordinary expenses, amounting to $125,000, charged to special reserve. President Wagner states that the sales of both gas and electricity have shown satisfactory increases, notwithstanding the widespread business and financial depression during the year, which merely had the effect of slightly retarding the normal growth of the company's business. The gross income from gas sales increased $124,713.55, or 3.8%, and the gross income from electric sales $227,261.21, or 7.4%.

THE combined net earnings available for dividends of the subsidiary companies of the MASSACHUSETTS GAS COMPANIES for August were $188,548, or $31,154 more than those of the corresponding month last year. Following are the August earnings in detail, with comparisons:

Gas department	1915	1914	1913
Boston	$73,847	64,643	48,446
Quincy	6,705	5,516	2,677
East Boston	5,673	*1,988	4,616
Newton	2,675	1,674	433
Totals	88,902	69,846	56,172
Coal department			
N. E. Gas & Coke	32,488	53,405	58,709
New England Coal	56,090	22,774	42,956
Federal Coal	8,748	6,565	3,273
Boston Tow Boat	2,318	4,801	3,710
Totals	99,645	87,547	108,651
Grand totals	188,548	157,393	164,823

* Deficit.

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